Aviation Week and Space Technology

A McGraw-Hill Publication

January 25, 1960

Woomera Range Prepares For Blue Streak

Titan Production Line

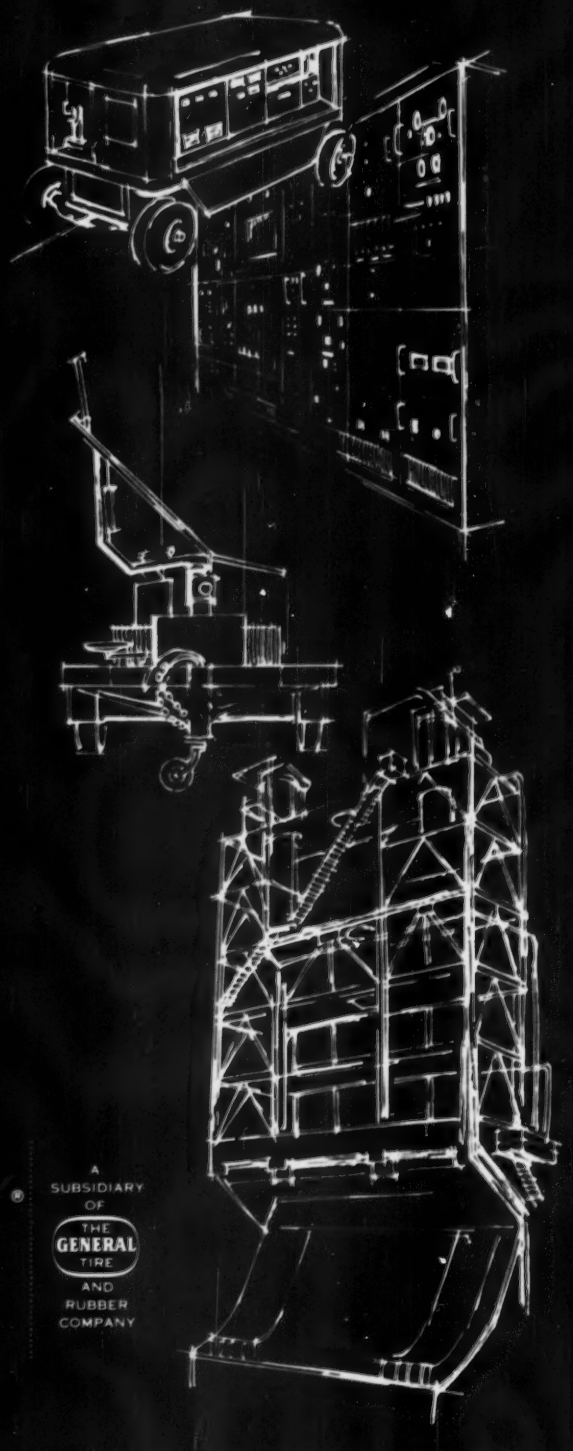
Special Report

1961 Defense, Space, FAA Budgets

GSE by AEROJET

Success in the air depends on support from the ground. Aerojet-General designs and manufactures all types of missile, surveillance drone, and space system ground support equipment.

- General Planning and Logistics
- Test and Launching Facilities
- Ground Handling & Servicing Equipment
- Checkout Systems
- Instrumentation and Control
- Data Systems
- Telemetry
- Communication Systems
- Radar Systems
- Space Position Instrumentation
- Miss Distance Measuring Sets

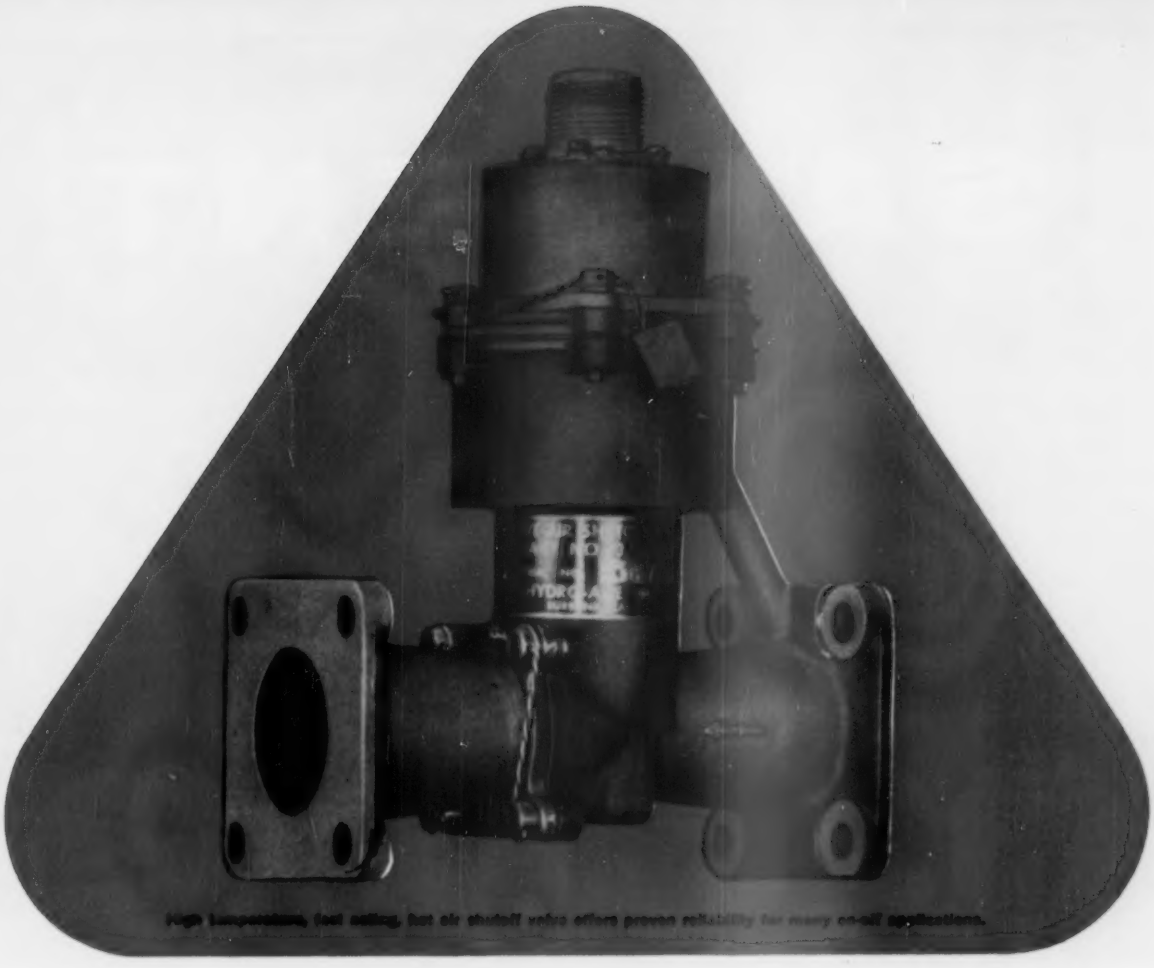


Aerojet-General® CORPORATION
Azusa, California

A SUBSIDIARY OF THE GENERAL TIRE AND RUBBER COMPANY

Plants at Azusa, Downey, San Ramon and near Sacramento, California; Frederick, Maryland

Engineers, scientists — investigate outstanding opportunities at Aerojet



Still *Another* Hydro-Aire Product for the *Aircraft* and *Missile* Industries

Hydro-Aire, producers of controls for every basic airborne system, has developed a family of pneumatic-powered, solenoid controlled, gate type hot air shutoff valves. Precision fabricated of stainless steel, with piston rings of S-Monel. The valves are extremely reliable, have minimum leakage, with positive on-off action under one second.

Performance and specifications:

Line size range: ½″ to 1¼″.
Inlet pressure range: 10 to 210 psig.
Ambient temperature: —65°F to 400°F.
Line temperature: to 730°F maximum.
Solenoid: 18 to 30 volts, DC.
Status: Fully qualified.
Design and engineering specifications: Available.

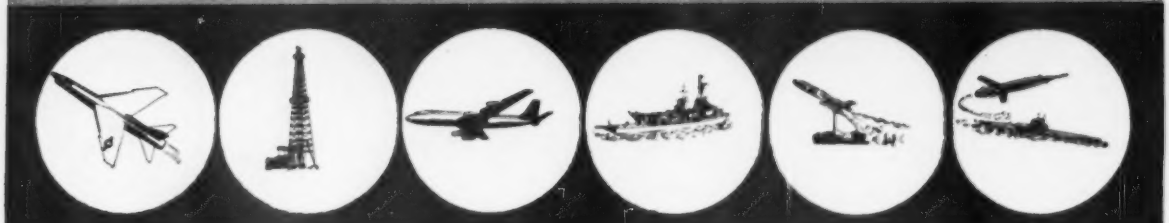
Investigate these or other designs for help in solving your control problems.

Engineers: Interesting opportunities are available. Write or call Mr. Douglas Nickerson, Chief Engineer, 3000 Winona Avenue, Burbank.

HYDRO-AIRE
BURBANK, CALIFORNIA
Division of CRANE CO
Developers and producers of reliable control components, sub-systems and systems for aircraft, missiles, electronics, transportation and general industry.

SARGENT

SERVO-SYSTEMS OF FORCE CONTROL



With 38 years acceptance Sargent builds precision linear and rotary hydraulic, pneumatic, mechanical and electronic systems of force control to meet successfully the increasingly high requirements of marine, aircraft, missile, petroleum and industrial use. From original idea to finished product – SARGENT.

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- Ball Screw Actuators
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"GOOD WILL" is the disposition of the pleased customer to return to the place where he has been well treated.
– U.S. Supreme Court

AVIATION CALENDAR

Feb. 3-5—1960 Winter Convention on Military Electronics, Institute of Radio Engineers, Biltmore Hotel, Los Angeles.

Feb. 4-6—Golden Gate Metals Conference on High Strength Steels, American Society for Metals, Fairmont Hotel, San Francisco, Calif.

Feb. 10-12—Seventh Annual Solid-State Circuits Conference, Philadelphia, Pa. Sponsors: Institute of Radio Engineers; American Institute of Electrical Engineers; University of Pennsylvania.

Feb. 16-17—Third annual National Missile/Space Conference and Dr. Robert H. Goddard Memorial Dinner, Sheraton Park Hotel, Washington, D. C.

Feb. 16-18—First National Symposium on Nondestructive Testing of Aircraft and Missile Components, Hilton Hotel, San Antonio, Tex. Sponsors: Southwest Section, Society for Nondestructive Testing; Southwest Research Institute.

Feb. 18-19—Symposium on Engineering Aspects of Magnetohydrodynamics, University of Pennsylvania, Philadelphia, Pa. Sponsor: American Institute of Electrical Engineers' Basic Sciences Committee.

Feb. 25-26—Seventh Scintillation Counter Symposium, Hotel Shoreham, Washington, D. C. Sponsors: American Institute of Electrical Engineers; Atomic Energy Commission; Institute of Radio Engineers; National Bureau of Standards.

Mar. 7-8—Fifth Annual Business Aircraft Safety Seminar, Dearborn Inn, Dearborn. Sponsor: Flight Safety Foundation.

Mar. 9-10—Symposium on "Processing Materials for Re-Entry Structures," Miami Hotel, Dayton, Ohio. Sponsor: Midwest Chapter, Society of Aircraft Material & Process Engineers.

Mar. 9-11—Conference on the Mechanical Properties of Engineering Ceramics, North Carolina State College, Raleigh, N. C. Sponsors: North Carolina State

(Continued on page 6)

AVIATION WEEK and Space Technology

January 25, 1960

Vol. 72, No. 4

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Engineering notes from the

SMI REPORTER

By STANLEY M. INGERSOLL, *Capabilities Engineer*

REPORT NO. 1

A new advance in pressure switching is embodied in our TR 2065. Through the use of solid state switching circuits*, SMI has developed a pressure switch which is extremely accurate and highly reliable. This new unit supplies a switch closure or opening on either an increasing or decreasing pressure and is ideally suited to applications where severe environments of temperature, vibration and shock are encountered.

For example, exhaustive tests of a 500 PSI unit have shown that it will not chatter when subjected to 50G's vibration when the pressure input is only 0.2% away from the switch point.

Essentially the TR 2065 is an SMI Bourdon Tube Pressure Transducer coupled with unique solid state switching circuits. The result is a pressure switch which is friction free and contains no moving parts in contact.

Principles of Operation As switching pressure is applied to the interior of the helically twisted Bourdon Tube, the tube rotates the armature attached to its end. The armature is positioned in a miniature, balanced, inductive bridge. A solid state electronic circuit receives the signal from the bridge and performs an extremely reliable switching function using minute amounts of energy, due to the elimination of friction and the minimizing of inertial forces.

Additional switch points may be added to the TR 2065 without adding more pressure sensing elements. Thus, as the number of operations increases, the size, weight and cost per switching point decreases.

Typical Specifications

Switch Point

Dynamic Stability:
Less than 0.25% of full scale when subjected to 60G's shock (10 m.s.) and vibration and 100G's shock

Vibration:
(10-55 cps 0.2" SA) (55-2000 cps 60g)

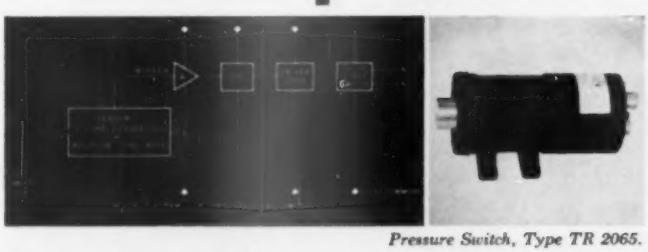
Hysterosis
0.1% of the pressure cycle experienced by the tube

Temperature:
(zero shift) 0.005% per °F
(scale factor) 0.001% °F

Long Term Drift
0.2% per year (approx.)

On-Off Differential
0.1% or better

Repeatability
0.1% of full scale



Pressure Switch, Type TR 2065.

What are your needs? If your immediate or future applications call for pressure switching, write or wire for complete information. Address your inquiry to Stanley M. Ingersoll, Capabilities Engineer.

**Patent applied for*

SMI

SERVOMECHANISMS, INC.

Los Angeles Division
12500 Aviation Boulevard
Hawthorne, California

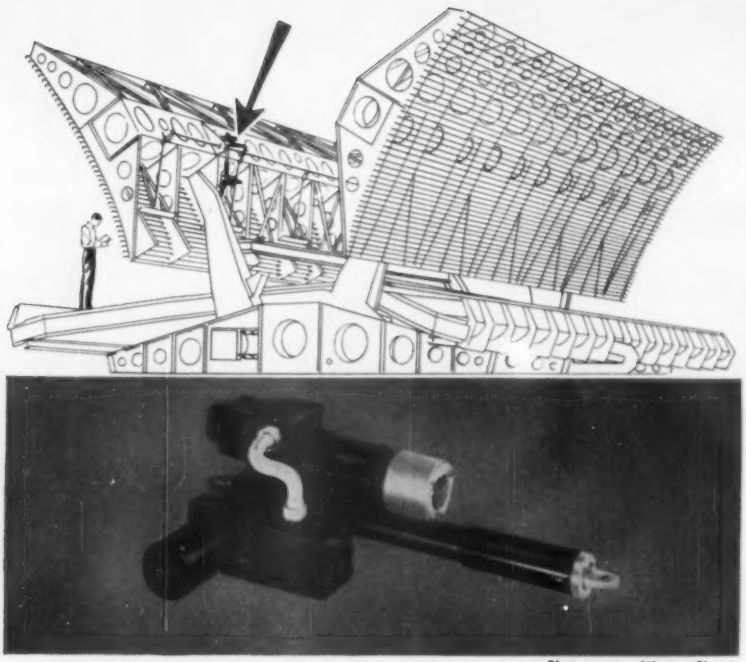


Photo courtesy Western Electric

R2552 LINEATOR exemplifies Airborne capabilities in large special actuators. Installed in pairs, units control tilt and shape of DEW Line antenna reflectors, must operate in temperatures from —65 to +130°F.

Airborne large special actuators used for DEW Line antenna control

Airborne large special actuators are being employed today in a diversity of applications, both air and ground. On the DEW Line, for example, pairs of Airborne R2552 LINEATOR actuators are used to control the tilt and shape of AN/FPS-19 antenna reflectors. Environment in this instance involves extreme temperature and humidity conditions and these call for a high order of mechanical and electrical reliability.

The R2552 typifies Airborne's capabilities in developing large special actuators—linear or rotary. And where requirements are not unique, we also offer a line of modular-type actuators, originated by Airborne to simplify design and specification. Write for further information.

GENERAL ENGINEERING DATA

Airborne Special Design
LINEATOR Actuator R2552

1. 208 v a-c, 60 cycle, 3 phase reversible induction motor with magnetic brake
2. Speed at rated load of 400 lb.: .3 in./sec.
3. Ambient temperature: -65 to +130°F. (-80°F. non-operating). Relative humidity: up to 100%
4. Design incorporates 2 limit switches and 4 intermediate position switches, plus synchro position transmitter.

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AVIATION CALENDAR

(*Continued from page 5*)

College School of Engineering; Office of Ordnance Research, U. S. Army.

Mar. 10-11—National Flight Propulsion Meeting (classified Secret), Institute of the Aeronautical Sciences, Cleveland, Ohio.

Mar. 17-18—Synchro Design and Testing Symposium, Department of Commerce Auditorium, Washington, D. C. Sponsor: Department of the Navy, Bureau of Naval Weapons.

Mar. 21-24—Institute of Radio Engineers' International Convention, Waldorf Astoria and Coliseum, New York, N. Y.

Mar. 23-25—Symposium on Optical Spectrometric Measurement of High Temperatures, University of Chicago, Chicago, Ill. Sponsors: University of Chicago's Applied Science Laboratories; Jarrell-Ash Co.; National Science Foundation.

Mar. 24-25—First Annual Symposium on Human Factors in Electronics, New York, N. Y. Sponsor: Institute of Radio Engineers' Professional Group on Human Factors in Electronics.

Apr. 4-8—Fourth Colloquium, Combustion and Propulsion Panel, Advisory Group for Aeronautical Research and Development, NATO, Milan, Italy. Subject: High Mach Number Air-Breathing Engines.

Apr. 5-8—1960 National Aeronautic Meeting and Missiles and Aircraft Engineering Display, Society of Automotive Engineers, Commodore Hotel, New York, N. Y.

Apr. 6-8—Structural Design of Space Vehicles Conference, Biltmore Hotel, Santa Barbara, Calif. Sponsor: American Rocket Society's Structures and Materials Committee.

Apr. 6-8—1960 National Meeting "Hyper-Environments—Space Frontier," Institute of Environmental Sciences, Biltmore Hotel, Los Angeles, Calif.

Apr. 12-13—14th Annual Spring Technical Conference, Institute of Radio Engineers in conjunction with the American Rocket Society, Hotel Alms, Cincinnati, Ohio.

Apr. 19-21—International Symposium on Active Networks and Feedback Systems, Engineering Societies Bldg., New York, N. Y. Sponsors: Polytechnic Institute of Brooklyn; Department of Defense Research Agencies; Institute of Radio Engineers.

Apr. 20-22 — National Symposium on Manned Space Stations, Institute of the Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif. Cosponsors: NASA; the Rand Corp.

Apr. 21-22—Southwest Metals & Minerals Conference "Metals and Materials for the Space Age," American Institute of Mining, Metallurgical and Petroleum Engineers, Ambassador Hotel, Los Angeles.

Apr. 27-28—National Meeting on Space Age Materials, Cincinnati Chapter of the American Society for Metals, Sheraton Gibson Hotel, Cincinnati, Ohio.

May 2-4—National Aeronautical Electronics Conference, Biltmore and Miami-Pick Hotels, Dayton, Ohio. Sponsor: Institute of Radio Engineers' Professional Group on Aeronautical and Navigational Electronics.

From General Motors . . . Temperatures Made to Order

PROTECTING THE HEART OF THE DELTA DART

HARRISON HEAT EXCHANGERS PROVIDE DUAL PROTECTION FOR CONVAIR F-106 . . . ALL-WEATHER JET INTERCEPTOR!

In a "red alert" . . . it's scramble and whoosh—altimeters soar above 50,000 ft.—thermometers dive below —50°! The devastating Dart—powered by a Pratt & Whitney J-75 turbojet engine in the 15,000 pound class—carries thousands of pounds of electronic eyes, muscles and brains plus deadly armament on its all-weather missions. Harrison heat exchangers provide dual protection for the Convair F-106 . . . controlling oil temperatures for the engine and the constant speed drive! Guarding vital operating temperatures on today's advanced aircraft is a Harrison specialty. It requires the engineering abilities, the research facilities and long experience in the heat-transfer field inherent in every Harrison product. If you have a cooling problem, look to the leader . . . rely on Harrison for the answer.

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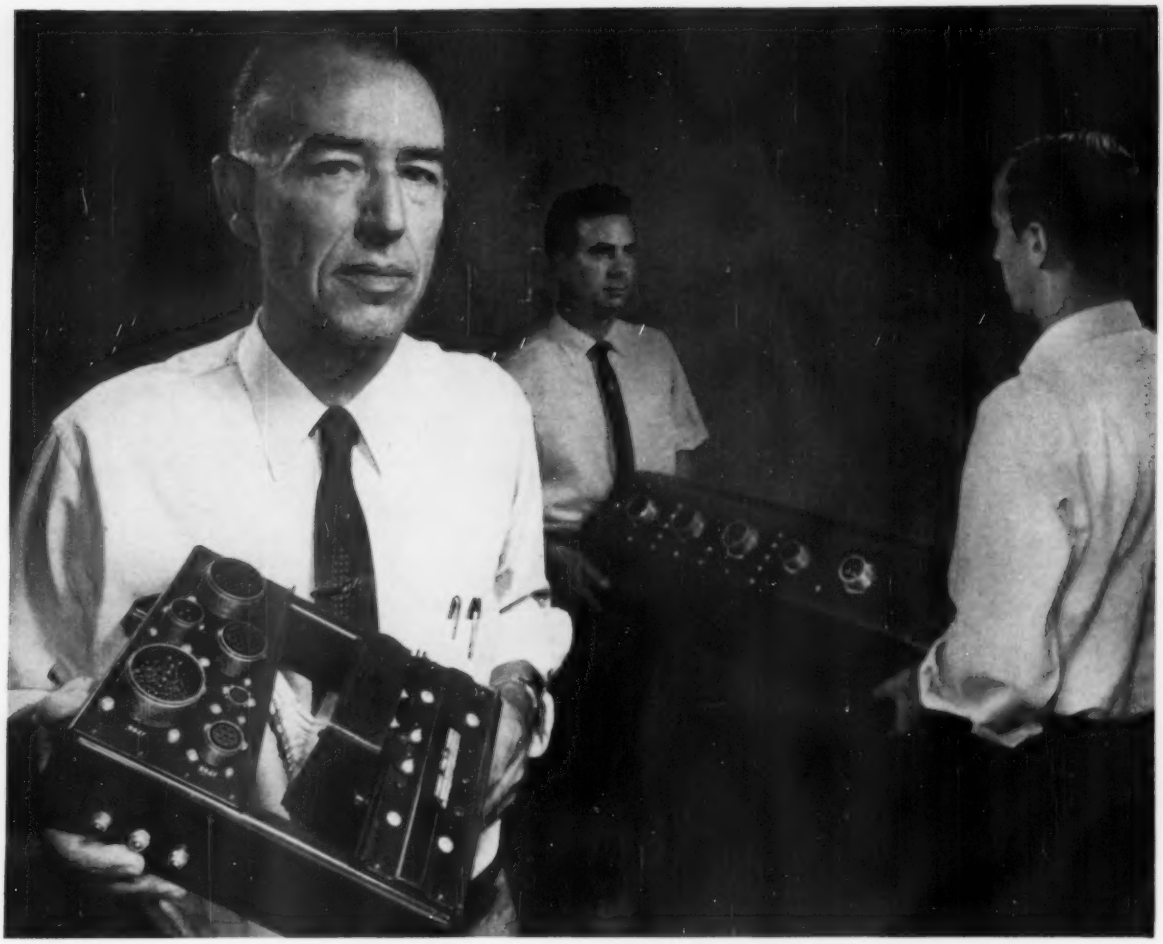
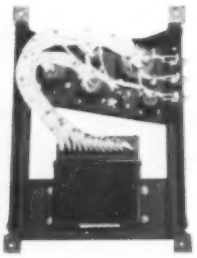
AIRCRAFT, AUTOMOTIVE, MARINE AND INDUSTRIAL HEAT EXCHANGERS

HARRISON RADIATOR DIVISION, GENERAL MOTORS CORPORATION, LOCKPORT, NEW YORK



Kinetics design shrinks missile switch from 50 lb to 7 lb



As shown in this bottom view, the actual switch is much smaller than the bracket. Kinetics can put a 200-pole, double-throw switch in less than 200 cubic inches.

The original main power changeover switch in the Atlas missile that switched from ground supply to internal electrical supply just prior to launch weighed 50 lb. Now, thanks to the design ingenuity of Convair-Astronautics engineers who cut the number of circuits from 32 to 20 and to Kinetics Corporation engineers who provided a new design concept, the switch and bracket assembly weighs only 7 lb. Since a pound of savings in the missile-borne weight adds about a mile to the missile's range, this saving is truly spectacular!

The new Kinetics motor-driven switch is more rugged and reliable than previous designs and is impervious to shock and vibration. A typical Kinetics switch exhibits no contact chatter over the whole vibration spectrum, from 5 to 2000 cycles, 40 G's. The voltage drop across typical switch contacts is less than 10 millivolts at 22 amp.

The high-density design results in many circuits per cubic inch, saving space. There are no permanent magnets or springs, no latching devices. This is truly a motor-driven switch using no elements of relays. The switch can be transferred at 40 G's, 2000 cycles. Once it's transferred, no power is required to hold it in position, saving batteries. Write or phone for more information on how this switch can be adapted to your requirements. Kinetics Corporation, Dept. K-17, 410 S. Cedros Avenue, Solana Beach, Calif. SKyline 5-1181.

KINETICS
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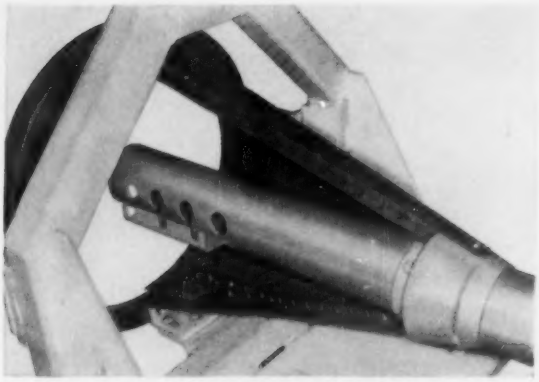
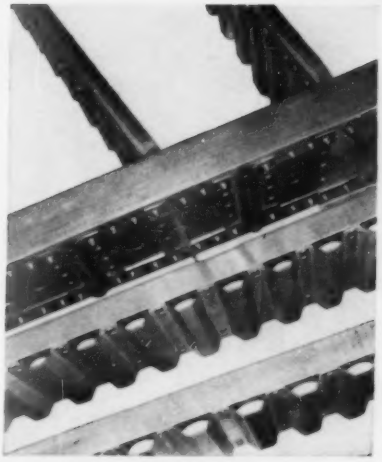
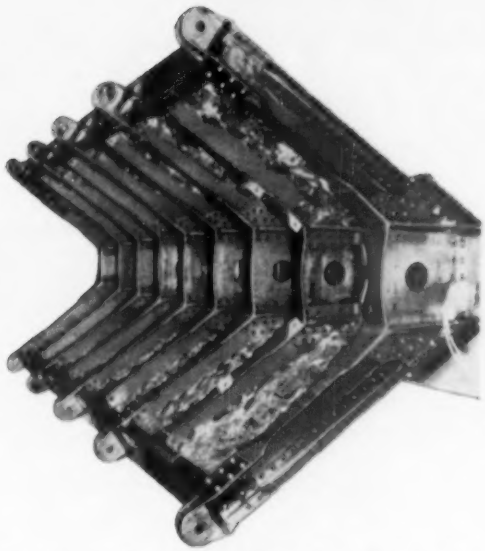


NOSE CONE SPLICE JOINTS ARE FASTENED WITH HS67 PINS, TYPE 431 STAINLESS STEEL, HEAT TREATED TO 125,000 PSI MINIMUM SHEAR. THE HS60M COLLARS ARE R MONEL.



WING SPARS, FRONT AND REAR, HAVE SPAR CAPS ATTACHED TO WEB SECTIONS WITH HS92 PINS, A286 ALLOY, HEAT TREATED TO 95,000 PSI MINIMUM SHEAR HS60M COLLARS ARE USED.

*X-15 .. A CHALLENGE FOR FASTENERS



WING ATTACH STRUCTURE IS ASSEMBLED WITH INTERFERENCE FIT HI-SHEAR RIVETS. THE HS128 PINS ARE 17-4PH STAINLESS STEEL, HEAT TREATED TO 120,000 PSI MINIMUM SHEAR. THE HS91 AND HS92 PINS ARE A-286 ALLOY, HEAT TREATED TO 95,000 PSI MINIMUM SHEAR. BOTH PINS USE HS60M R MONEL COLLARS.

The X-15 research vehicle . . . ready for the first manned probe into space . . . with speeds exceeding 3600 mph . . . for altitudes above 100 miles . . . to withstand 1200° F . . . a challenge for fastening techniques.

The selection of the Hi-Shear rivet for use in the X-15 is an outstanding example of how this and other high strength fasteners are being developed at Hi-Shear research facilities to keep pace with the ever changing requirements of the aircraft and missile industries.

The Hi-Shear rivet *still* offers the *lightest strength-weight ratio* of any swaged type fastener, simplicity of installation and service reliability established by sixteen years acceptance by industry.

Contact your Engineering Standards Group or write to us for specific fastener data.

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*"HI-SHEAR" TRADEMARK REGISTERED U.S. PAT. OFFICE. U.S. PATENTS 2,355,579; 2,355,580; D-178,579; OTHER U.S. AND FOREIGN PATENTS PENDING.

HIGH SPEED LIGHTWEIGHT RELIABILITY

*ACTUAL SIZE OF THE .05

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STRATOPOWER announces the availability of their newest product in the field of hydraulics — STRATOPOWER HYDRAULIC MOTORS. The dependable, light weight design of STRATOPOWER hydraulic motors offers you a brand new degree of versatility.

STRATOPOWER can now provide a complete line in their family of fixed and variable hydraulic motors — sizes are available ranging from .05 to 4.5 cubic inches of displacement per revolution.

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Qualified engineers in hydraulic and control design are invited to investigate their potential as a member of the STRATOPOWER organization. Please contact Mr. Watkins, Personnel Manager.

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DEVELOPED BY SUNDSTRAND FOR BOEING B-52H

Selection of Sundstrand drives for the B-52H . . . greatly advanced version of Strategic Air Command's B-52 Stratofortress . . . is a direct reflection of the outstanding performance and reliability demonstrated on leading jet-powered military and commercial aircraft now in service.

Sundstrand has also developed and manufactured 20-kva . . . 40-kva . . . and 60-kva drives, delivering a total of more than 27,000 units for 39 major aircraft and missile programs, and compiling an unequaled experience of more than 7,000,000 drive flight hours.

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NEW SUPER HIGH-STRENGTH FASTENER

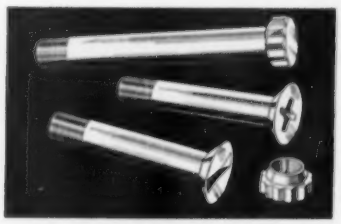
. . . shear values to 156,000 psi, temperature ratings to 900°F

What happens to fastener strength at Mach 3-4 skin temperatures? Shown is a special electric furnace used to produce a high-temperature environment for a bolt under tension at the SPS laboratories for advanced fastener research.

Imagine the design advantages of bolts offering more than *twice* the shear strength of an AN-4 Series. You could achieve major weight savings by using one bolt in place of two—or by specifying smaller sizes. Or you could substitute size for size in existing joints and greatly increase strength and reliability.

Such bolts are not only compatible with today's high-strength materials, but are now being manufactured by SPS—in standard sizes #10-32 through ¾-18, with companion locknuts. They have 40 to 60% greater shear strength than present high-strength aircraft shear fasteners. Fatigue resistance is excellent. And they are available not only for 500°F service, but also—with special finish—for service to 900°F.

These new super high-strength shear bolts are another important achievement of the SPS laboratories for advanced fastener research . . . results of the continuing search for fasteners with higher and higher strength-to-weight ratios needed to meet the performance demands of a Space-Age technology. For complete information on bolts and companion locknuts, write SPS—manufacturer of precision-threaded fasteners and allied products in many metals, including titanium, beryllium and other exotic materials.



SPS SHEAR BOLTS*

Bolt	156,000 psi shear	132,000 psi shear
100° Flush Head (Hi-Torque® Drive)	SFH 26	SFH 22
100° Flush Head (Torq-Set® Drive)	SFT 26	SFT 22
12-Point (External Drive)	EWSB 26	EWSB 22

*Shown are room-temperature part numbers. See Bulletin 2477 . . . for 900° fasteners, Bulletin 2478.

®Hi-Torque Pat. Nos. 2,677,985; 2,745,120 (other U.S. and Foreign Patents)

®Torq-Set Pat. Nos. 494,726; 558,663 (other U.S. and Foreign Patents)

AIRCRAFT/MISSILE Division

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SPS WESTERN, SANTA ANA, CALIFORNIA

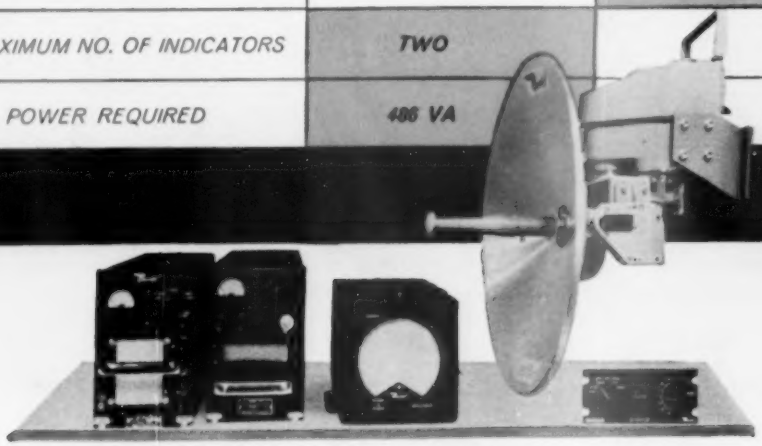
SPS

where reliability replaces probability

BENDIX RDR-1D AIRBORNE WEATHER RADAR WINS IN SIDE-BY-SIDE COMPARISON!

Only Bendix has this proved performance superiority

	BENDIX RDR-1D SYSTEM	OTHER X-BAND MAKE
RACK SPACE REQUIRED	**TWO 1/2 ATRs**	TWO 3/4 ATRs (SHORT)
RANGE	**UP TO 150 MILES**	UP TO 80 MILES
STABILIZED ANTENNA	**YES**	NO
SCAN ANGLE	**120°**	80°
ANTENNA TILT	**±15°**	±10°
WEIGHT	82 LBS	**50 TO 57 LBS**
MAXIMUM NO. OF INDICATORS	**TWO**	ONE
AC POWER REQUIRED	**486 VA**	515 VA



Bendix RDR-1D System—TSO-C63

Pending FAA regulations have put airborne weather radar in the limelight . . . and emphasized once more the importance of using the most efficient system. Detailed comparison reveals that the Bendix RDR-1D System offers superior performance which means maximum flying safety for all types of aircraft.

The RDR-1D "sees" farther . . . up to 150 nautical miles. Its stabilized antenna prevents loss of picture while maneuvering . . . and the wider scan angle allows the pilot to see 50 per cent more target area.

Today over 1,500 Bendix Airborne Weather Radar Systems are now in daily service with airlines and business aircraft operators throughout the world.

For more details on the Bendix RDR-1D, the weather radar system *with experience*, write:

Bendix Radio Division
AVIONICS GROUP • BALTIMORE 4, MARYLAND

Bendix
AVIATION CORPORATION

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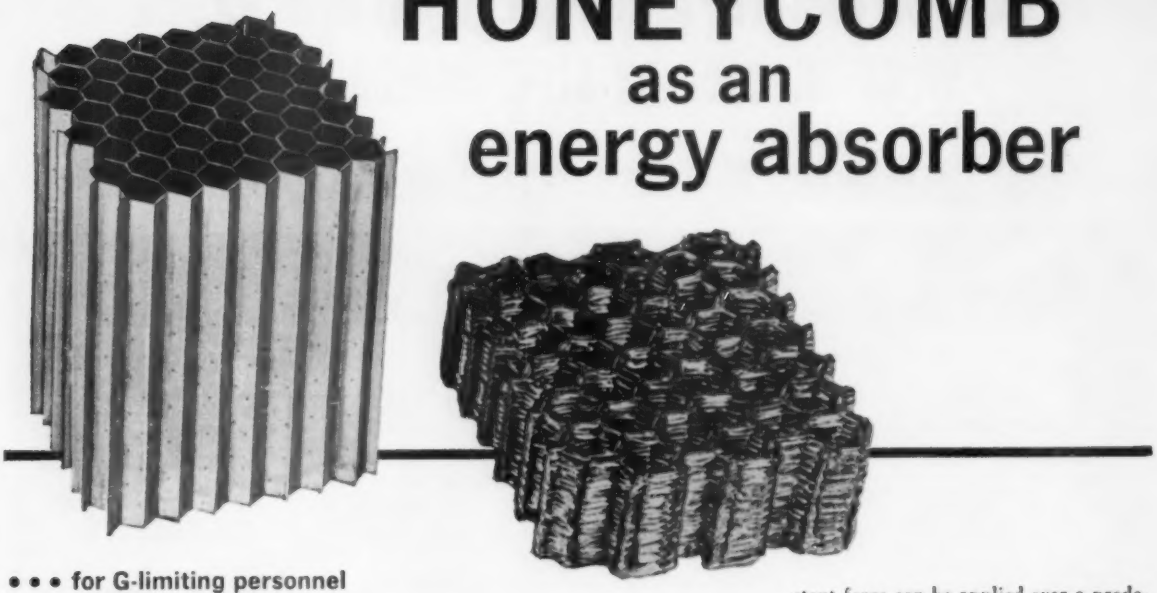
HONEYCOMB as an energy absorber



- • • for G-limiting personnel protection devices
- • • for protecting air-dropped supplies
- • • for impact limiting safety linkages
- • • for missile instrument recovery assemblies
- • • and other applications to limit destructive G-loads to pre-determined levels

While honeycomb materials are used principally in light-weight, high-strength sandwich structures, increasing emphasis has been placed on the use of honeycomb to control forces exerted on decelerating objects. Such control is highly desirable in cushioning the impact of air-dropped supplies, protecting instrumented missile assemblies, providing impact-limiting linkages in landing gear structures, packaging fragile items, and protecting human occupants of high speed vehicles.

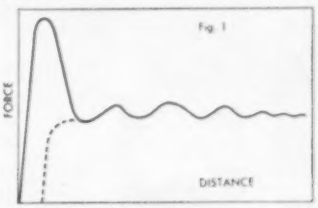
The Problem

Instances requiring impact energy absorption are generally typified by low tolerable deceleration rates for the structure or its contents, high impact velocities, and small maximum allowable stopping distances. Such absorbers as mechanical springs, sponge or solid rubber, foams, cork, and wadding generally exhibit spring characteristics, in that the force transmitted through these absorbers to the object being stopped increases continuously through the distance in which the absorbers contract. In addition, many of these materials do not absorb energy, but merely store it for release as rebound energy.

If an absorber could exert a relatively constant non-rebound force throughout the entire stopping distance, that distance could be shortened, or alternately, the maximum force acting on the object in the same stopping distance could be materially reduced.

Advantages of Honeycomb

Honeycomb core materials tend to follow such a constant force curve, as shown in Figure 1.



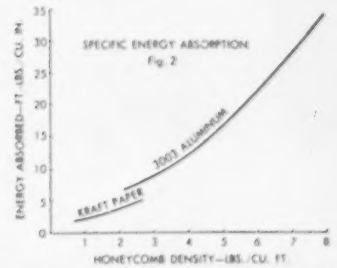
The initial peak on the curve represents the point at which compressive failure begins. This peak can be lowered by prestressing the core to produce slight initial compressive failure. When subjected to further or subsequent loading, the prestressed core proceeds immediately to carry the crushing load, as shown by the dashed line curve in Figure 1.

The main illustration shows the appearance of aluminum honeycomb core before and after compressive failure.

By designing a honeycomb core assembly with a specified cell depth this constant force can be applied over a predetermined stopping distance.

Available Materials

These principles apply to aluminum and paper honeycomb, and most similar honeycomb core materials fabricated from ductile metals and fabrics. Figure 2 indicates the general range of energy absorption capacity available in aluminum and paper materials.



These capacities can be further increased by filling the cells with various foamed materials. Detailed information is available to assist the designer in the specific selection of a core material for exact requirements.

Optimum Solution

The choice of materials by the designer will depend upon the particular requirements of the application. But it seems apparent that the utilization of honeycomb offers the optimum solution—in terms of weight and volumetric efficiency—to many types of energy absorption problems.

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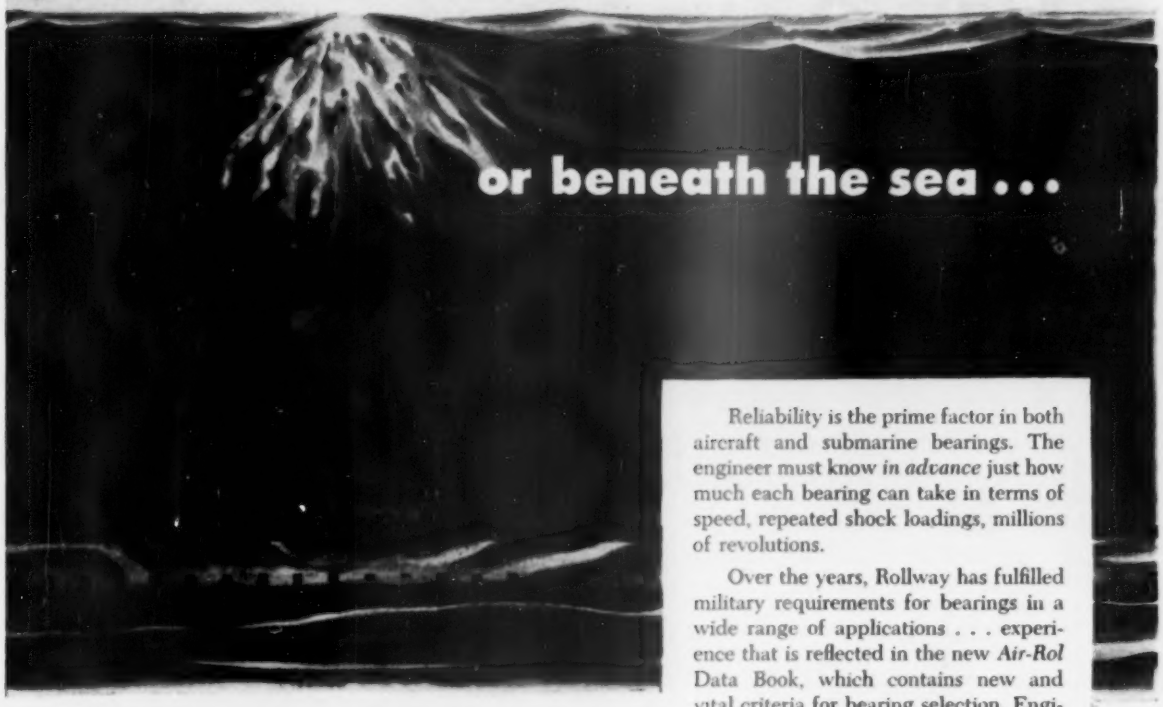

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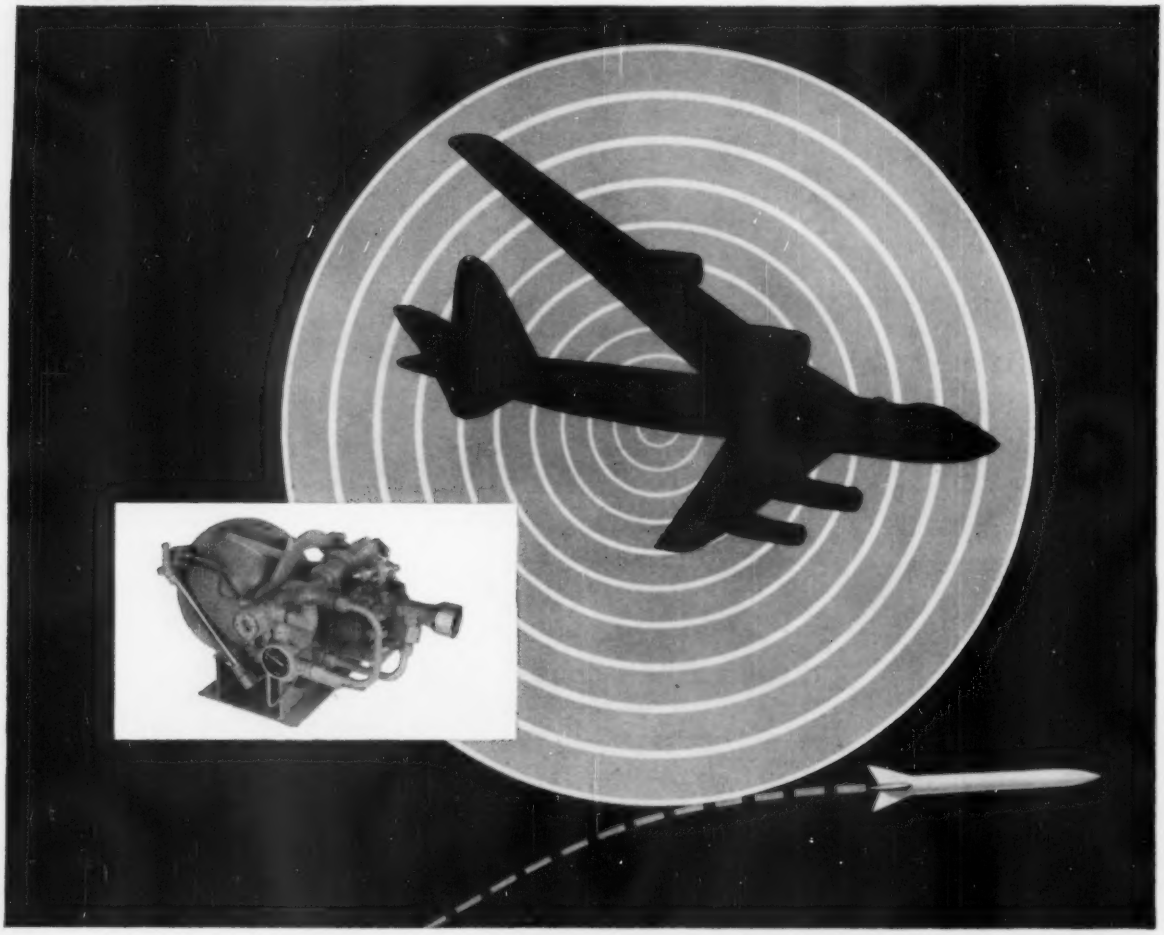

HOW TO HOLD A JAM SESSION 8 MILES UP

Vickers active cooling system (inset) uses FC-75 in countermeasures system

The increasing sophistication of electronic countermeasures systems poses many problems. Among them—how to cool vital components at the environmental and operational extremes encountered in sonic and supersonic aircraft.

For the Sperry countermeasures system, a new airborne active cooling system—capable of dissipating 47KW in a 74-lb. package—was developed by Vickers using 3M Dielectric Coolant FC-75.

This most stable of all fluids offered to electronics has high electric strength of 37KV. It is self-healing, and maintains electric strength after repeated high voltage arcing. It pours at —148°F and boils at 212°F at one atmosphere . . . ideally suited for evaporative cooling.

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3M COMPANY

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3M's FC-75 dissipates 47 kw input in 74 lb package

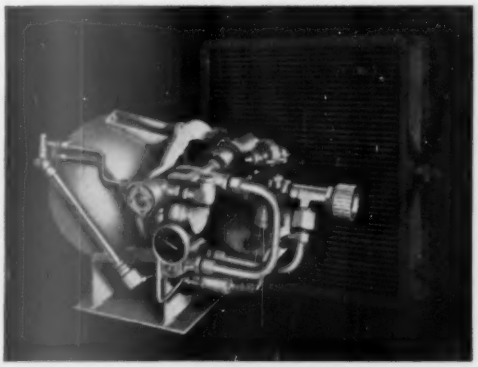
Vickers' 38 years of specializing in handling of fluids has been directed to "application-tailored" airborne cooling systems . . . reliable systems that are light weight and feature a broad range of flow and pressure characteristics.

This typical Vickers system circulates Minnesota Mining and Manufacturing Co.'s heat dissipating dielectric coolant, FC-75, through Sperry's advanced design electronic countermeasures system.

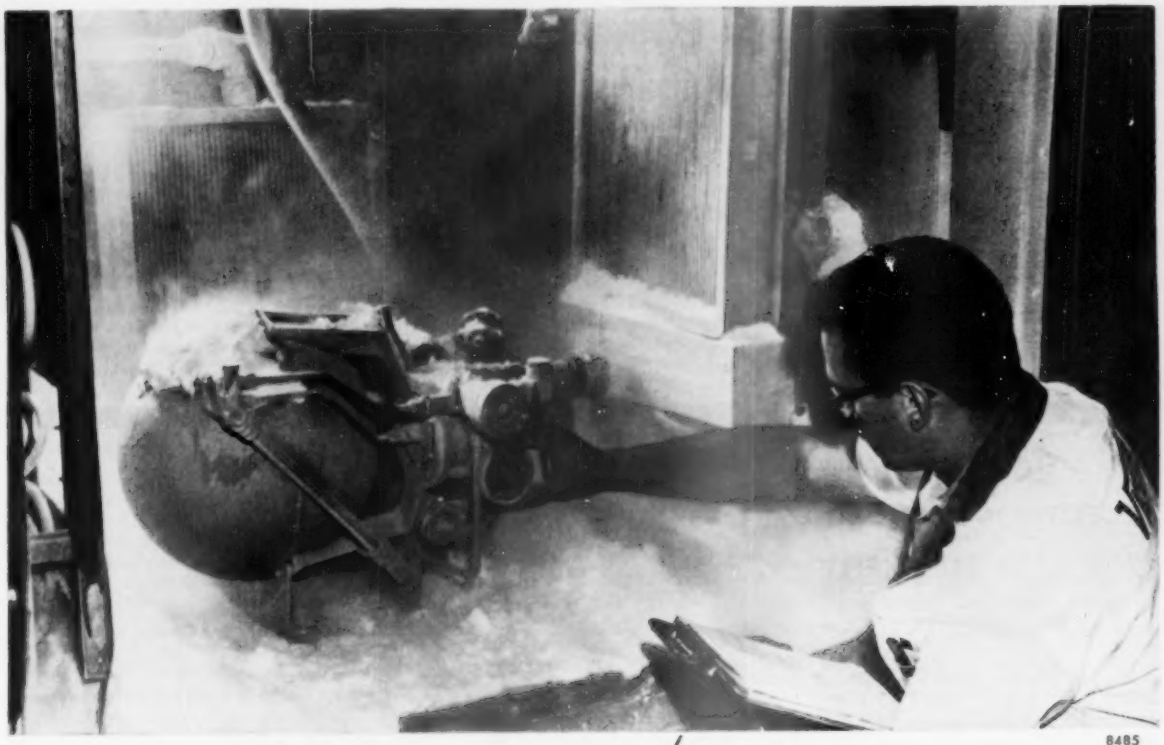
Heart of the Vickers cooling system is a single-stage, centrifugal pump that generates relatively low pressure and moves fluids at high flow rates. Because it is inherently simple in design, the Vickers pump offers high reliability and simplifies maintenance. Bearing design permits operation with fluids having low viscosities, in this instance FC-75, a fluordinated hydrocarbon.

Included in this package are safety interlocking devices for the protection of the pumping unit and ECM system. Maximum operating efficiency is assured even under unusually severe operating requirements. Such assurance stems from Vickers proven skills developed by long experience in designing and building components and systems for handling all types of fluid.

Write for Bulletin A-5244 for more details.



PUMPING UNIT AND CORE. Large airborne cooling system developed by Vickers' Aero Hydraulic Products division makes efficient use of 3M's FC-75 dielectric coolant to dissipate heat from electronic countermeasures equipment. Output pressure is required to be approximately 100 psi with fluid flow rates as high as 52 gpm. Operating range is from —65°F to 210°F. Pumping unit weighs 54 lb. dry and the heat exchanger core only an additional 20 lb. Shown below is part of the extensive testing program conducted by Vickers to prove out the new design. It included extremes of heat and cold as well as vibration, shock, attitude and other physical tests.



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AERO HYDRAULICS DIVISION
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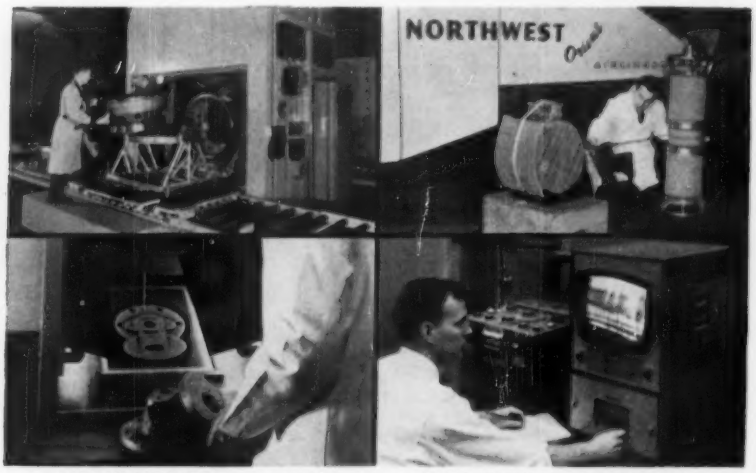

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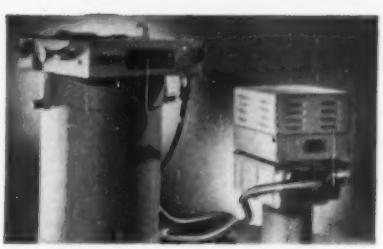

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President Asks $41 Billion for Defense..... 26
▶ Fiscal 1961 new orders to total $42.412 billion; expenditures expected to reach $40.995 billion.

FAA Budget Stresses Airway Needs..... 37
▶ Agency's Fiscal 1961 requests total $654 million; represent $143.5 million increase over this year.

Woomera Range Prepares for Blue Streak Launch.. 52
▶ Australian rocket range is in midst of highest spending program as firing of Atlas-sized British missile approaches.

SPACE TECHNOLOGY

NASA $802 Million Request May Grow 29
Soviets Plan Biological Satellites.... 32
Martin Nuclear Rocket Plan..... 34
Soviet Manned Satellite..... 35

MISSILE ENGINEERING

Woomera Prepares for Blue Streak.. 52
Tunnel Design Improves Data..... 64

AERONAUTICAL ENGINEERING

Nuclear Plane Radiation Hazards... 113
Fiat 7002 Nears Completion..... 112
Production Briefing 118
New Aviation Products 135

AVIONICS

Services to Exchange Avionic Data.. 67
Navy Designs New Type Radar..... 33
Giannini to Build Pyrotechnic Gyro.. 77
Filter Center 77
New Avionic Products 82

FINANCIAL

Retired Officers' Salaries Detailed... 121
Stock Transactions 127
New Offerings 131

SAFETY

Factors Leading to Electra Crash.... 136

AIR TRANSPORT

FAA Budget Stresses Airway Needs.. 37
FAA Causes Pilot Anxiety..... 38
Pilots Protest Electra Crash Ruling. 39
Turbofan Cargo 707, DC-8 Favored.. 41
Convair 600 Performance Gains.... 41
Western Seeks Funds for Jets..... 41
New York Harbor Airport Site..... 43
DH-121 Fuel Increase Planned 48
Aeroflot Plans Faster Service for 1960 50
Shortlines 45
Airline Observer 45
Airline Income & Expenses..... 47

MANAGEMENT

President Asks $41 Billion for Defense 26
Soviet Missile Lead Downgraded.... 31
USAF Tightens Rules..... 36
Industry Observer 23
Who's Where 23
Washington Roundup 25
News Digest 36

BUSINESS FLYING

Super Broussard to Fly in Spring.... 87
Picchio F.15 Has Good Control..... 94
Catalina Island Opened to Planes... 101
Poland May Expand Glider Sales... 106
Cessna Unit Sales Rose in 1959.... 106
U. S. Lightplane Shipments..... 107
Private Lines 109

Calendar 5
Letters 166

EDITORIAL

Small Steps Taken Slowly..... 21

COVER: Photo shows production of the USAF-Martin Titan intercontinental ballistic missile at Martin's Denver Division; first and second stages are in various phases of assembly. A completed first stage (shrouded at top right) is ready for shipment to Cape Canaveral, Fla. Second stage behind it is undergoing final shipping preparations.

PICTURE CREDITS

Cover—Martin Co.; 32—Canadair; 34—Martin Co.; 48, 49—de Havilland Aircraft; 53 (right)—British Ministry of Supply; 64—Cornell Aeronautical Laboratory; 65—USAF; 82—Hooker Chemical Corp.; 94, 95, 97, 99—D. A. Anderton, Procaer; 101—Santa Catalina Island Co.; 107—Fletcher Aviation Corp.; 109—Greensboro-High Point Air Service, Inc.; 112, 133—D. A. Anderton; 113—Saab; 119, 155—Dassault; 137—Eastfoto; 150—Bristol Aircraft, Ltd.; 153—Sikorsky; 156—Grumman.

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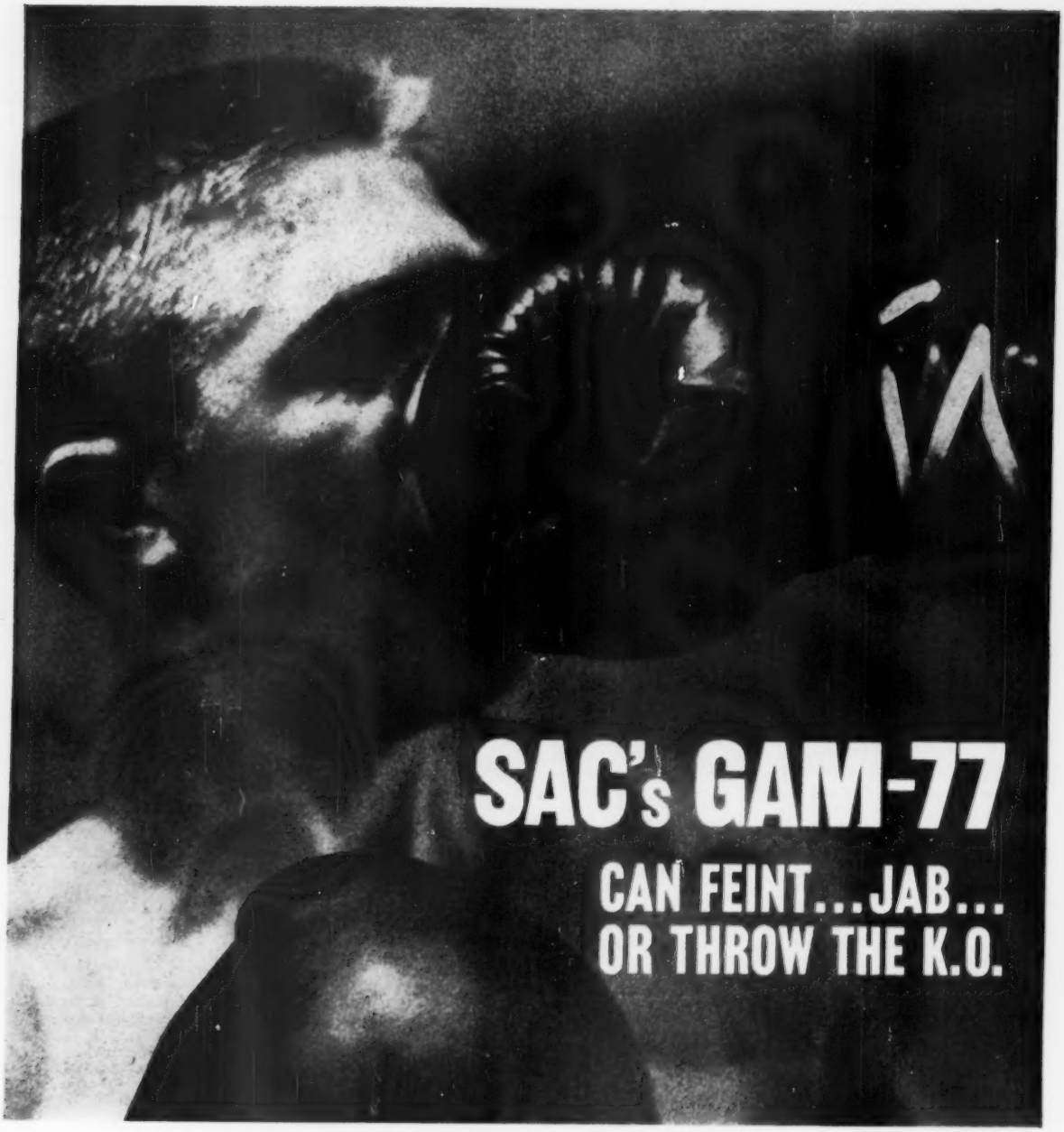

GAM-77 HOUND DOG air-to-surface missiles give SAC's B-52G intercontinental bombers the versatility of a champion boxer. Even while the aircraft carrying the GAM-77 missiles is airborne, a new target can be selected. Then reaching out at supersonic speeds after launch, the GAM-77's can flatten opposition for the bomber to deliver its own Sunday punch... or independently destroy the primary target. These jet-powered missiles vastly increase the striking power of the giant Boeing B-52... give it a triple-punch capability.

Guided by a self-contained inertial autonavigator—set before launch by the B-52's crew—the GAM-77 can't be jammed, can't be decoyed. The GAM-77 Hound Dog was designed and is being produced for the USAF by the Missile Division of North American Aviation.

MISSILE DIVISION

NORTH AMERICAN AVIATION, INC.

Downey, California

EDITORIAL

Small Steps Taken Slowly

The federal budget for Fiscal 1961 submitted to Congress by the President last week fails badly to meet the rising U.S. requirements in the aerospace field. It is a budget wrapped in rosy optimism that is belied by almost every fact available and is aimed at creating an illusion of security and progress while avoiding the real cost of such attainments. It is pretty much the same old mixture served during the past five years.

Its chief consolation probably lies in the fact that this is the last such effort by the group that has been responsible for this philosophy of national leadership and that, regardless of which political party is victorious in the fall election, a fundamental change in attitude toward these problems should result.

The Fiscal 1961 budget in most of its aerospace aspects is aimed at taking small steps forward at the slowest possible pace that will still offer some external evidence of progress. It has been tailored to fit an arbitrary budget ceiling rather than aimed at computing the price of this country's genuine requirements for continued world leadership and domestic strength.

The most obvious deficiency is in the National Aeronautics and Space Administration where the President in his budget message made much of the "doubled" expenditures projected for Fiscal 1961 with an $802 million budget. This increase over the admittedly inadequate Fiscal 1960 NASA starting budget represents only a small real increase in the space effort since much of the alleged "doubling" simply comes from the bookkeeping shift of the Saturn booster program from the Pentagon budget to NASA.

In all fairness to Keith Glennan, NASA administrator, he put up a dogged battle with the White House for a more realistic space budget for Fiscal 1961. But, like almost every other government executive who has tried to push a positive aggressive program in recent years, he has been vetoed by his superiors and will not really deserve all of the lumps an angry Congress is sure to give him when the space budget comes under its critical scrutiny.

The initial NASA budget last year was badly underestimated and poorly programed. The increases allowed for Fiscal 1961 will barely cover these deficiencies and will not permit an aggressive and expanding space research program with the pace and scope to establish our international leadership in this area.

In the Defense budget the illusion of a relatively stable budget level during the past few years is aimed at concealing the fact that rising costs and expanding technology have actually translated this constant fiscal level into a steady decline of relative military strength. Any private enterprise that ran its business on the fiscal policies of the defense budget would find itself badly outstripped by its competition in a few years. The progress in our military program cited by the President in his budget message is undeniably true. Our military strength is certainly greater than it was a few years ago. But what he carefully omits is any reference to our rate of progress relative to our potential enemies' progress and our strength as compared with that of these opponents.

To conceal this growing gap the Administration has blandly changed its basic ground rules on intelligence. Now, intelligence was never a precise science, but the top-level estimators in this government have underestimated virtually every new Soviet development in military technology except one—the decision to curtail Bison bomber production several years ago. On the basis of this single overestimate and in the face of dozens of underestimates it has been decided to change the interpretation scale of intelligence from using the enemy's capability to using his supposed intent.

Those who were in uniform in the Navy and Munitions Buildings in the pre-Pearl Harbor days may recall that it was precisely this type of thinking that led to the debacle in Hawaii. Knowledge that the Japanese carrier striking force had left its home bases was available in Washington days before the attack at Hawaii. But our military leaders misgaged the enemy's intent. They thought he would strike in Southeast Asia at Malaya and the East Indies and never credited him with the audacity to smash at Hawaii.

By this bald switch of intelligence ground rules, the Administration has "abolished" the missile gap that former Defense Secretary McElroy admitted only last year would be, at least 3 to 1 in favor of the USSR in the early years of this decade. Other knowledgeable observers estimated it as high as 10 to 1. What new device will be employed to "explain" away the significance of the Soviet 8,500-mi. missile shots already plunking into the Pacific we cannot imagine. But perhaps ex-artilleryman Harry S. Truman can explain to the American people what a 2,000-mi. range advantage would mean in a missile shooting match.

Among the bright spots in the Defense budget are the initial provisions for developing an airborne alert capability for Strategic Air Command; at long last modernizing the Army's weapons including man-carried atomic field weapons and truly mobile missiles; postponing a decision to commit a multi-billion dollar production program for Nike Zeus until the technical aspects of this weapon are tested more thoroughly and realistically, and an increase in the Atlas ICBM production and deployment program advocated by Administration critics a year ago.

Another bright spot is the Federal Aviation Agency budget where Elwood R. "Pete" Quesada, FAA administrator, appears to be the only government agency head able to convince the White House of the need for an expanding program. The FAA budget contains a modest increase for badly needed research and development and larger increases for procurement and installation of modern electronic equipment for the federal airways and traffic control systems.

Despite its many and obvious deficiencies there will probably be no significant change in the Fiscal 1961 budget as it passes through Congress. It will be used primarily to provide campaign issues and speech material with any basic policy changes awaiting the outcome of the election next fall.

—Robert Hotz

Plastic fastened to metal— firm and weather-tight with RIVNUTS®

Large transparent plastic panels form the cockpit windows of the Vertol Aircraft Company's new YHC-1A helicopter. The plastic is firmly secured to the airframe by B. F. Goodrich RIVNUTS. About 300 are installed—quickly and easily—resulting in a finished seal that withstands both vibration and weather extremes.

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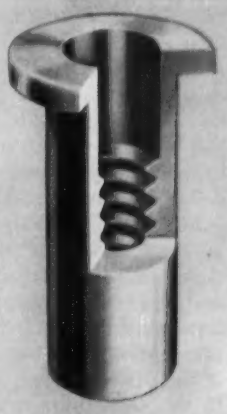
This use of blind-fastening RIVNUTS insures a simple and very satisfactory method of window installation. In case after case, RIVNUTS speed assembly, cut labor costs, simplify design. If you'd like recommendations on a specific fastening problem, please send a print of your part.



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WHO'S WHERE

In the Front Office

James D. McLean, president, Stromberg-Carlson Division of General Dynamics Corp., Rochester, N. Y., succeeding **Robert C. Tait** who continues as a senior vice president of General Dynamics with new corporate-wide responsibilities. Mr. McLean also will be a senior vice president of General Dynamics and a member of the corporation's Board of Management. Also: **Allan R. Shilts,** vice president and general manager of the Stromberg-Carlson Division.

Dr. T. F. Walkowicz and **Dr. David T. Griggs,** directors, FMA, Inc., El Segundo, Calif. Dr. Walkowicz is an associate of Laurance S. Rockefeller, and Dr. Griggs is professor of geophysics at the University of California and former USAF chief scientist.

Dr. Herbert Trotter, Jr., president of General Telephone & Electronics Corp.'s newly formed research subsidiary, General Telephone & Electronics Laboratories, Inc., New York, N. Y.

Kenneth G. Farrar, vice president-manufacturing, Douglas Aircraft Co., Inc., Santa Monica, Calif., succeeding **Frederic W. Conant, retiring.** Mr. Conant will continue as a director. Also: **Harold G. Hynd** succeeds Mr. Farrar as vice president-general manager, Long Beach Division; **Jesse L. Jones** succeeds Mr. Hynd as vice president-general manager, El Segundo Division; **John R. Allen,** general manager, Tulsa Division.

A. V. Roe Canada, Ltd., Toronto, Canada, has announced the following appointments in the Aeronautical Group: **Kenneth W. Brown,** vice president-general manager, Avro Aircraft, Ltd.; **John L. Plant,** vice president-general manager, Canadian Applied Research, Ltd.; **Burton A. Avery,** vice president-assistant general manager, Orenda Engines, Ltd.

Roger Bowen and **James Cannon,** vice presidents, Cannon Electric Co., Los Angeles, Calif.

E. Haynes, program manager, Exploratory Research and Reliability Branch, Advanced Research Projects Agency, Washington.

Andre Esperet, assistant to the president, United Aircraft Corp., East Hartford, Conn.

Jennings David, vice president-engineering, Summers Gyroscope Co., Santa Monica.

Adm. Sherman E. Burroughs, Jr. (USN, ret.), special assistant to the president, Librascope Division of General Precision, Inc., Glendale, Calif.

Milton B. Ames, Jr., deputy director of the Office of Advanced Research Programs, National Aeronautics and Space Administration, Washington, D. C.

Richard B. Leng, group vice president of Packard Bell Electronics Corp.'s newly formed Defense and Industry Group, Los Angeles, Calif., which incorporates the company's Technical Products Division; Packard Bell Computer Corp., a division; and Technical Industries Corp., a subsidiary.

Honors and Elections

Igor I. Sikorsky, aeronautical pioneer, has received the cross of Chevalier of the Legion of Honor from French Ambassador Herve Alphand in Washington, D. C.

INDUSTRY OBSERVER

► Ninth vehicle in the Air Force Project Discoverer series is scheduled to be launched near end of January. Lockheed Missile and Space Division, project manager for the program, has been intensively re-working the satellite's re-entry and recovery systems in an effort to remedy the cause of past malfunctions that have foiled recovery attempts.

► **Cal-Val R&D Corp., Woodland Hills, Calif., has submitted feasibility and preliminary design data to National Aeronautics and Space Administration, the Advanced Research Projects Agency and Navy for a mobile shipboard launch system to accommodate boost vehicles ranging from one and one-half to six million pounds thrust—minimizing the effects of acoustics, vibration and heat. Another proposal for test facilities to handle rocket engines in the 6-to-24 million lb. thrust category also has been submitted by the company to NASA, USAF's Ballistic Missile Division and other government agencies.**

► Possible use of storable liquid propellants in the booster stage only of later versions of the Minuteman ICBM has not been ruled out, although the planning thus far has not contemplated a specific timetable. Liquids could give precise fuel cutoff for more accurate targeting.

► **Degree of rail mobility of the Minuteman will hinge largely upon the total number of miles of track made available for missile deployment plus the length of track each complete missile train will use. Limitation also will have a direct bearing upon the number of Minuteman silo deployments in relation to the over-all deployment plan.**

► General Accounting Office is planning a survey of the entire Thor intermediate range ballistic missile program in England. Study probably will include all aspects of the program with which USAF support has been or will be associated.

► **Air Force is establishing a calibration laboratory under the general cognizance of the Air Materiel Command and under the specific control of its Dayton, Ohio, Air Force Depot to control standards in aircraft and missile production. The establishment of such a facility has been planned for some time.**

► National Aeronautics and Space Administration will use a Lockheed F-104 for an air launch of a Viper sounding rocket, probably in the vicinity of Edwards AFB, Calif. Launch procedure methods already have begun. The launch will be made during a loop of the F-104. Pilots are practicing loops beginning at 25,000 ft. and going over the top at 50,000 ft.

► **Goodyear Aircraft Corp. has submitted a proposal to Air Force for its Ballute recovery system in which balloons would be used to brake the speed of space capsules following re-entry.**

► View ports for Mercury space capsules will be made of four panes of polished high-temperature glass, each separated by airspace. Rectangular panels being produced by Corning Glass Works are designed to withstand the same re-entry stresses as the capsules' triple-layered metal walls. Ports will permit crewman to determine the capsule's attitude and to take astronomical photographs.

► **Navy believes it will be able to keep Polaris solid-propellant fleet ballistic missiles stored in their submarine launch tubes for periods of up to five years before removing them for shore checkout of the electronics and propellant systems. Missiles will be constantly monitored by automatic checkout systems aboard the submarines.**

► The Martin Co. is evaluating the feasibility of entering the field of submarine construction in a further move toward diversification. Lockheed Aircraft entered this field last year with its acquired interest in the Puget Sound Bridge and Dredging Co. (AW Apr. 6, p. 37).

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Washington Roundup

Budget Formulation

Here's how the Fiscal 1961 defense budget was formulated, according to Defense Secretary Thomas S. Gates, Jr.:

"It was considered, in the light of the international situation, the state of military technology, and the general economic and fiscal situation, that the 1960 level of expenditures—about $41 billion—would be a reasonable point of departure for the preparation of the 1961 defense budget. This was to serve as a general guide and not as a final determination of the 1961 budget—either in total or for the individual services.

"In order to assist in bringing the major issues into focus, it was agreed that each of the military departments would use planning objectives aggregating somewhat less than the 1960 level for the development of what we call their basic budgets. It was contemplated that these basic budgets would include the hard core of top priority requirements for combat-ready forces, military hardware and new weapon systems development, together with the related construction.

"In addition, each service was requested to submit up to $500 million in new obligational authority above the 1960 level for any other desirable programs, bringing the total new obligational authority to about $43.7 billion and net expenditures to about $41.8 billion. Furthermore, the services were not precluded from submitting items over and above these limits, and, in fact, the Army, Air Force and Advanced Research Projects Agency did just that.

"All the budget requests, totaling $43.9 billion in new obligational authority and $42.6 billion in net expenditures, were then reviewed by the staff of the Office of the Secretary of Defense by program—on a defense-wide, across the board basis.

"This year, a particular effort was made to assure that all the principal officials of the Department of Defense—the service secretaries, the assistant secretaries of defense and the chiefs of staff, both in their individual capacities and in their corporate capacity as the Joint Chiefs of Staff—participated in the review of the annual program and budget."

Air Force Shifts

Leading contender to succeed Dr. Joseph V. Charyk as assistant secretary of the air force for research and development is Dr. Jerome B. Wiesner, director of Massachusetts Institute of Technology's Electronics Research Laboratory and a member of the President's scientific advisory group. Charyk was nominated by President Eisenhower last week for the post of Air Force undersecretary, replacing Dudley C. Sharp, new secretary of the Air Force.

Pentagon Shuffles

In other Pentagon shuffles, Lawrence P. Gise, assistant director of the Advanced Research Projects Agency, is moving into the slot of ARPA deputy director, and Army Maj. Gen. John A. Dabney is being given the special task of reviewing defense testimony before joint hearings of the Senate Space and Preparedness Committees for security and publication.

Gise, a former assistant director of Atomic Energy Commission's Division of Military Application, succeeds Air Force Maj. Gen. Don R. Ostrander, who was recently appointed director of the Office of Launch Vehicle Programs at the National Aeronautics and Space Administration. Defense Secretary Thomas S. Gates, Jr., said the appointment of Gen. Dabney was made at the request of the space committees and to "enable an especially quick review of such material without seriously slowing down . . . day-to-day security review."

State Department Views Space

Undersecretary of State Livingston T. Merchant told the House Committee on Science and Astronautics last week that the Department of State "fully supports a strong and vigorous outer space effort" to counter Soviet accomplishments in this field. While bowing to U.S. efforts thus far, which he said have provided "substantial and significant achievements" and are "sounder and broader than that of the Soviet Union," Merchant told the committee:

"As much as developments in any other area, the events in outer space of the past two years have made it clear to all that the Soviet threat is neither purely political nor short term. The Soviet accomplishments in this field are witness to strong scientific, technical and industrial capabilities, organizational effectiveness in concentrated effort, and they reflect growing military strength. These are sobering facts. But the danger to ourselves would come not from recognition of these facts, but from refusal to recognize them."

Galloping Terminology

Air Force, in an effort to contain the galloping terminology generated by the space age, is advising its contractors and personnel to avoid the term "outer space." Here's the reason as outlined in a USAF newsletter:

" 'Outer Space,' a term much used these days, probably is intended to mean the expanse beyond the earth's upper atmosphere. Implied in the term is another region: 'inner space.' This supposedly would be the expanse from the earth's surface to where 'outer space' begins. No one, of course, can say, except arbitrarily, where 'outer space' begins and 'inner space' ends.

"In any event, the term 'outer space' implies that we are in space ('inner space') when on the surface of the earth. In a general sense this is true, because 'space' is the expanse surrounding the universe's celestial bodies (including our planet earth).

"Because of its vagueness the term 'outer space' should generally be avoided in Air Force usage. If writing or speaking on the total expanse beyond the earth's surface, use the term 'aerospace.' If differentiating between the atmosphere and the region beyond it refer to 'air' and 'space' or 'atmosphere' and 'space.' "

Smith Leads Stadium Drive

C. R. Smith, American Airlines president, has been named to head a national campaign to raise $3.5 million for the construction of an Air Force Academy football stadium. Smith will direct the fund drive in conjunction with the Air Force Academy Foundation, Inc., which was organized to conduct the drive because appropriated funds cannot be used to build a stadium. Plans call for a 40,000-seat stadium for use by the academy football team by the 1962 season. **—Washington staff**

President Asks $41 Billion for Defense

Fiscal 1961 new orders to total $42.412 billion; expenditures expected to reach $40.995 billion.

By Evert Clark

Washington—Eisenhower Administration last week asked Congress for a $79.8 billion budget that would hold defense spending at approximately the $41 billion level of the past two years and continue to reflect the shift toward missiles in all three services.

Total national budget request is $1.4 billion more than the Administration requested last year, but expected revenues of $84 billion would give the government a surplus of $4.2 billion at the end of Fiscal 1961.

Emphasis throughout the President's budget message to Congress was on economy and sound fiscal policy. He said the amount requested for the military services "will provide the strong and versatile defense which we require under prevailing world conditions."

Defense Department is asking for $40.927 billion in new funds—$150 million less than last year. It also has $350 million available in transfers from previous years. Defense expects to place new orders totaling $42.412 billion, $733 million more than last year. It expects to pay out $40.995 billion in the coming fiscal year, a figure that is $50 million higher than last year.

Continuing a practice begun last year, Defense is reducing the number of major budget categories. Research and development category was expanded last year to include test and evaluation of weapons. Funds previously carried in procurement accounts to support various phases of development, test and evaluation began to be moved into this new R&D category last year. This year, the shift has almost been completed. Below are Defense's Fiscal 1961 estimates:

• **Procurement of all types.** New money requested is $13.085 billion, $5 million lower than last year. The new orders to be placed will total $14.364 billion, which is $759 million higher than last year. Expenditures will be $13.602 billion, $341 million below last year's figure.

• **Aircraft procurement.** New funds requested declined by $1.39 billion from last year, dropping from $6.143 billion in Fiscal 1960 to $4.753 billion this year. New orders will increase slightly from $5.940 billion to $6.013 billion. Expenditures will decline by $643 million, from $6.67 billion last year to $6.027 billion.

• **Missile procurement.** New money requested is $581 million higher than last year, rising from $3.244 billion to $3.825 billion. Orders increased by $265 million, from $3.54 billion to $3.805 billion. Missile expenditures will decrease by $121 million from $3.5 billion last year to $3.479 billion.

• **Research, development, test** and evaluation. New money asked is $3.91 billion, a decrease of $279 million. Orders decreased by $316 million, from $4.268 billion last year to $3.952 billion. Expenditures will increase slightly, rising from $3.68 billion to $3.917 billion for a gain of $237 million.

• **Operation and maintenance.** New money rises $210 million to $10.527 billion; orders will rise $227 million to $10.527 billion. Expenditures will rise $184 million to $10.321 billion. Cost per unit of flying hours is up 11% from two years ago and cost of steaming hours for ships is up 15% in the same period, Defense said. Overhaul of one B-58 engine costs about six times that of overhauling one B-47 engine; annual cost of operating a nuclear submarine is more than three times the cost of operating a conventional one, and the cost of maintaining SAGE and other elements of major military communications systems has increased more than 70% in two years, Defense said.

• **Military construction.** New money requested is $1.188 billion, a decline of $176 million. Orders will be $1.382 billion, a decline of $115 million. Ex-

Major Expenditures & Obligations

(In Millions of Dollars)

	N.O.A.* FY 1959	Direct Obligations	Expend. FY 1959 (Actual)	N.O.A.* FY 1960	Direct Obligations	Expend. FY 1960 (Est.)	N.O.A.* FY 1961	Direct Obligations	Expend. FY 1961 (Est.)
Air Force									
Aircraft	4,421	5,130	5,393	4,285	4,176	4,879	2,994	4,002	4,232
Missiles	2,923	2,607	2,295	2,466	2,671	2,639	3,024	2,941	2,669
Research, Development, Test & Evaluation	1,375	1,222	1,081	1,435	1,527	1,270	1,334	1,338	1,261
Operation & Maintenance	4,267	4,267	4,361	4,344	4,344	4,225	4,458	4,458	4,385
Navy									
Aircraft	1,649	1,820	2,152	1,739	1,646	1,683	1,640	1,875	1,663
Missiles	543	540	319	379	469	389	450	464	397
Research, Development, Test & Evaluation	1,172	1,147	900	1,255	1,251	1,131	1,169	1,208	1,266
Operation & Maintenance	2,618	2,598	2,676	2,685	2,674	2,639	2,726	2,726	2,615
Army									
Aircraft	64	54	113	119	117	108	119	136	132
Missiles	642	555	725	399	400	472	351	401	413
Research, Development, Test & Evaluation	1,042	1,022	800	1,064	1,101	1,016	1,042	1,042	1,003
Operation & Maintenance	3,244	3,233	3,314	3,235	3,299	3,223	3,276	3,276	3,264

* New Obligational Authority

penditures will be $1.359 billion, a drop of $311 million. Almost half of this money will go toward missile bases construction.

• **Manpower.** Totals at the end of Fiscal 1961 are expected to be the same as at the end of the current fiscal year. Army will have 870,000 men, a decrease of 9,000 from the end of Fiscal 1959; Air Force will have 825,000 men, down 15,000 from the end of Fiscal 1959; Navy will have 619,000, down 7,000 from 1959; and Marine Corps will have 175,000, down 1,000 from 1959.

Space Appropriations

Space came in for about the same share of the Defense budget that it did last year before the Saturn booster was transferred to the National Aeronautics and Space Administration. New money will be $400 million and expenditures $366 million.

Defense Secretary Thomas S. Gates, Jr., said in budget hearings there is no long-range military space program separate and distinct from the over-all defense program. Space vehicles are being applied to defense problems in four specific areas—reconnaissance, early warning, navigation and communication.

Space funds are identified separately only in the research and development accounts. Figures are $67 million for Advanced Research Projects Agency, $1.3 million for Navy and $249,740,161 for USAF. No funds are listed for Army.

Military assistance to other countries, consisting largely of equipment bought through the services, will total $2 billion in new money and $1.75 billion in expenditures. Of this, $363 million is for aircraft, $262 million for missiles and $165 million for electronics. Missiles and electronics are up by almost $100 million each and aircraft by $200 million.

A total of 1,510 aircraft will be bought in the Defense budget exclusive of military assistance. This is 99 more than the number being purchased in the current year—but 1,000 more than the Administration said it intended to buy when it first presented the Fiscal 1960 budget a year ago. USAF buys 633, Navy 658 and Army 219.

Breakdowns of military force strengths and service budget requests for Fiscal 1959, 1960 and 1961 are contained in accompanying tables.

USAF Program

Highlights of the USAF program for Fiscal 1961 are:

• **Convair Atlas ICBM** is now programed for 13 squadrons of 10 each instead of 9 and Martin Titan for 14 squadrons instead of 11. All 13 Atlas bases are funded in the new budget. Lead time components are funded for

Airpower Program

	Actual June 30, 1959	Planned June 30, 1960	Planned June 30, 1961
Air Force			
Combat wings (total)	105	96	91
Strategic wings	43	40	38
Air defense wings	27	23	20
Tactical wings	35	33	33
Combat support flying forces (total)	145	118	115
Air refueling squadrons	60	62	66
MATS air transport squadrons	27	22	21
Other specialized squadrons	58	34	28
Active aircraft inventory	20,890	19,513	18,885
Navy			
Attack carrier air groups	16	16	16
Carrier anti-submarine air groups*	....	11	11
Patrol and warning squadrons	42	42	41
Marine air wings	3	3	3
Active aircraft inventory	9,649	8,657	8,348
Army			
Field artillery missile groups (heavy) (Redstone)	3	3	3
Army missile commands	4	4	5
Guided missile anti-aircraft battalions (equivalents)	74	73¼	82¼
Separate surface-to-surface missile battalions	18	24	26
Active aircraft inventory (total)	5,199	5,663	5,791
Helicopters	2,357	2,714	2,840
Fixed-wing	2,842	2,949	2,951

*Prior to 1960, the carrier anti-submarine capability was represented by 22 carrier ASW squadrons which have been reorganized into 11 carrier ASW Air Groups.

Expenditures for Procurement & RDT&E

(Adjusted for comparability with FY 1961 appropriation structure.)
(millions of dollars)

	FY 1959	FY 1960	FY 1961
Procurement			
Army—Total	1,388	1,251	1,198
Aircraft	113	108	132
Missiles	725	472	413
Ships	2	3	4
Other	548	669	650
Navy—Total	4,464	4,322	4,355
Aircraft	2,152	1,683	1,663
Missiles	319	389	397
Ships	1,488	1,647	1,640
Other	506	602	654
Air Force—Total	8,554	8,369	8,049
Aircraft	5,393	4,879	4,232
Missiles	2,295	2,639	2,669
Ships	.....	.....	.....
Other	867	850	1,147
Research, Development, Test and Evaluation			
Army	800	1,016	1,003
Navy	900	1,131	1,266
Air Force	1,081	1,270	1,261
Office of Secretary of Defense	78	263	387

'Common' Fighter

Washington—Possibility that the Air Force-Republic F-105 fighter-bomber might be used as a Marine Corps close support aircraft and that one of three existing aircraft—including the Navy-McDonnell F4H—might be used as a continental defense interceptor is being considered by Defense Department. USAF already is buying the F-105 for close ground support of Army.

12 Atlas squadrons and installations and checkout equipment is funded for 10 Atlas squadrons. First Titan is to be operational in the summer of 1961. Congress last year added $85 million to Defense's requests and insisted on 17 Atlas and 11 Titan squadrons. Defense used the money but changed the ratio. New money includes funds to give Titan storable fuels. Secretary Gates said Titan "has a greater growth potential in terms of warhead capability and range. It also has the better potential for the storable fuel which will make it simpler to handle and also make a much more ready missile. When it becomes operationally satisfactory, it will do many things better than the Atlas. It will just be a better missile in all respects . . . Titan will significantly increase the number of megatons you can deliver."

• **Airborne alert.** This is being increased from $20 million in 1960 to $90 million in 1961, principally for spare engines. Gates said he had heard that Strategic Air Command wanted "everything from $600 million up, for one-quarter of the force on continuous . . . alert." There is no significant airborne alert now. Gates said, but "a sizable portion" of the Boeing B-52 force can be "continuously in the air for brief periods during times of tension." Additional B-52Gs will become operational in Fiscal 1961, making a total of 13 B-52 wings, and one wing of 45 B-52Hs will be bought in Fiscal 1961.

• **Thirty Convair B-58s** are being bought in 1961 at a cost of $3.097 billion. The B-58C, which would use the Pratt & Whitney J58 engine and be all supersonic, is being studied. USAF request of $564.7 million for B-58 procurement was reduced to $500 million.

• **North American B-70,** which would have cost $5.5 billion and been operational in quantity in 1965, has been pared from the USAF request of $463.9 million to $75 million, about the same as in the current budget. Defense Director of Engineering Herbert York said review to see what subsystems must be kept going is still open, as reported by AVIATION WEEK (Jan. 4, p. 22). The B-70 relies on "metals and components that are still in the purely research stage," Secretary Gates said.

• **Air defense.** Request of $5.5 billion was cut to $3.9 billion. Sixteen Boeing Bomarc interceptor squadrons for the U. S. and two for Canada are programed. Four will be operational by June 30 and four more in Fiscal 1961. Last A-models were bought in Fiscal 1959. Budget in Fiscal 1961 for B-models is $421.5 million. Entry of Bomarcs into the inventory won't be completed until 1963. North American F-108 which was canceled, would have cost $4 billion and been available in operational quantities in the mid-1960s.

• **North American Hound Dog.** Two squadrons will be in service by June 30. Fiscal 1961 funding of $170 million will supply missiles through 1962.

• **Douglas air-launched** ballistic missile, to enter the force in 1964, is funded for $60 million in Fiscal 1961.

• **Minuteman solid-propellant ICBM.** Money for assembly facilities near Salt Lake City, Utah, and for long lead time components are in the new budget. Money to study use of railroad cars for launching also is included. Missile is to be operational by mid-1963.

• **Nuclear aircraft is funded** at $75 million by USAF and $79.7 million by Atomic Energy Commission.

• **Dyna-Soar boost glider** is funded for about $52 million, up 50% from Fiscal 1960.

• **Martin Mace missile.** Funded for $39.8 million in 1961 following funding of $125 million in Fiscal 1960 to provide a squadron for Germany and one for Okinawa by December of 1961.

• **Republic F-105 fighter-bomber.** Increase of funding over 1960 is 50%.

Navy will begin construction of 20 new ships and conversion of 15 others in Fiscal 1961 and will receive 19 new ships, six nuclear submarines, three Polaris submarines and a converted missile cruiser begun in other years. These include the Forrestal-class attack carriers Constellation and Kitty Hawk, and the first nuclear cruiser Long Beach.

New ship construction includes a conventional-powered carrier at a cost of $290 million, $130 million less than the price for a nuclear-powered carrier. Three more Polaris missile submarines will be bought and first of the Polaris submarines is scheduled to be on station by December of this year, with missiles. Polaris program is funded at $952,212,000 in Fiscal 1961.

Anti-submarine warfare is funded at $1.37 billion in research and development and procurement funds for 1961. Breakdown is $64.2 million for ships and conversion; $45 million for research and development; $21.3 for aircraft and related procurement; $6.8 million for ordnance and ammunition. Navy also used the $137.3 million extra that Congress gave it last year for ASW, putting $45 million into research and development and the rest into procurement.

Navy also will buy the McDonnell F4H and Chance Vought F8U-2N at the 1960 level and buy the North American A3J, the Lockheed GV-1 tanker-assault transport for the Marine Corps, the Grumman S2F-3 and the Lockheed P3V. Marine Corps will get its first flight refueling squadron.

Missiles to be purchased by Navy include the Lockheed Polaris, Bendix Talos, Convair Terrier and Tartar, Raytheon Sparrow, Philco-General Electric Sidewinder and the Zuni. Marine Corps will get the Martin Bullpup, two battalions of Raytheon Hawks, Convair Redeye air defense missile, and the Army-developed Davy Crockett, a man-carried nuclear rocket.

Defense will spend $300 million for full-scale tests of Army's Nike Zeus without nuclear warheads. Despite insistence by Congress, it is not being put into production, partly as a result of a study by the President's Science Advisory Board last August. Defense considers it a point defense weapon and says it would cost $14 to $15 billion to defend U. S. cities with Zeus. Whether it will be produced should be decided this year. Secretary Gates said technical problems are "staggering." The $137 million extra provided by Congress last year for Zeus production is being held over into 1961.

New budget also contains $111.4 million to buy the last major elements of the Nike Hercules anti-aircraft missile. Army also will buy the 500-750 mi. Martin Pershing, Emerson Electric-Douglas improved Honest John, Emerson Electric Little John, Martin Lacrosse, Sperry Sergeant, Raytheon Hawk, an anti-tank missile and the Davy Crockett. The Crockett is under Army Ordnance Weapons Command and work is done by Rock Island, Picatinny and Frankford arsenals.

Army aviation funds are up 35% over Fiscal 1960. Procurement will include Grumman Mohawk observation planes, de Havilland Caribou assault transport, Bell Iroquois helicopter and the first production quantity of the Vertol Chinook helicopter.

Bomarc B Abort Cause

Washington—First five test launchings of the Air Force-Boeing Bomarc B interceptor missile were unsuccessful because improper valve functioning kept the Marquardt ramjet engines from operating properly, according to Defense Secretary Thomas S. Gates, Jr. Solid-fuel booster "worked properly" in all five shots, Gates said. "The trouble has been definitely pinpointed and the tests will start again the end of this month," he said.

NASA $802 Million Request May Grow

By Craig Lewis

Washington—Congress was asked last week to approve $802 million in new money for the National Aeronautics and Space Administration in Fiscal 1961, but the budget estimates are likely to be increased in an effort to accelerate the super booster program, including Saturn.

The Saturn project is now scheduled for $140 million in the Fiscal 1961 NASA budget as compared with Defense Department funding for the project of $27 million in 1959 and $77 million this year, but the Administration has authorized overtime expenses and increased spending for the program. This means NASA probably will have to ask for more funds as soon as the agency decides just how much should be spent to accelerate the program.

Actual spending for research and development under NASA's proposed 1961 budget will almost double, going from $325 million in the current fiscal year to $600 million next year. Of these totals, NASA is spending $268 million to conduct research and development programs and $57 million for associated facilities this year, and the agency plans to spend $503 million for programs and $97 million for facilities next year.

The $802 million budget request for new obligational authority for the next fiscal year includes $545,153,000 for research and development, $89,287,000 for construction and equipment and $167,560,000 for salaries and expenses. Congress appropriated $500,575,000 for NASA thus far in the current year. A $23 million supplemental request for Fiscal 1960 is now pending.

Although the Fiscal 1961 NASA budget will go through the customary separate authorization and appropriation processes in Congress, the Administration will ask Congress to amend the space law so that future appropriations will not have to go through the preliminary authorization process. Construction and equipment category, a traditional field for close congressional examination, will be the only exception to this proposed change.

Supplemental

Administration request for a supplemental Fiscal 1961 appropriation of $23 million is part of the amount authorized but not appropriated last summer by Congress (AW Jan. 11, p. 25). NASA plans to spend $12 million of this for Project Mercury research and development and $7 million for the Mercury tracking network. NASA already has transferred $15 million from current research and development funds to enlarge the tracking net program. The remaining $4 million in the supplemental request will go for construction of the Centaur pad complex at the Atlantic Missile Range.

Another supplement request probably will be made to deal with President Eisenhower's approval of an acceleration in the super booster program. The President told NASA Administrator T. Keith Glennan "it is essential to press forward vigorously to increase our capability in high thrust space vehicles." He asked Glennan to study and report as soon as possible on the amount of money needed in Fiscal 1960 and 1961 to accelerate the super booster program, which includes Saturn and the 1.5 million lb. thrust F-1 engine under development by North American Aviation's Rocketdyne Division.

Eisenhower also authorized Glennan to use as much overtime as he thinks necessary on the Saturn project. NASA has enough latitude in its current program planning to handle increased Saturn expenses for a time, but a supplemental request will have to be submitted fairly soon unless other programs are made to suffer from the costs of accelerating the Saturn program and of developing the liquid hydrogen upper stages planned for the Saturn vehicle (AW Jan. 11, p. 26).

Comparative Increase

Transfer of Saturn makes comparisons between current NASA spending authority and the obligational authority requested for next year difficult. Subtracting the $140 million Saturn program from the $802 million 1961 total leaves $662 million. Adding the $23 million supplemental request to the $500 million 1960 spending authority, which did not include the Saturn program, gives a 1960 figure of $523 million. This indicates a comparative increase of $139 million in spending authority for the coming fiscal year for the space budget, excluding Saturn.

Actual research and development spending for the two years is also clouded by Saturn, but $370 million for Fiscal 1960 and $634 million for 1961 appear to be the best comparative spending figures which include Saturn. The 1960 total includes NASA's $325 million in regular and supplemental budget spending, plus $45 million spent for Saturn by the Defense Department this year under its industrial funding program at the Army Ballistic Missile Agency. In Fiscal 1961, the Defense Department will spend $34 million on Saturn left over from previous authorizations, and this figure is added to NASA's $600 million spending budget to get the $634 million 1961 comparison.

Of the $140 million NASA has scheduled for Saturn under current Fiscal 1961 budget plans, $11.7 million will be for research and development work at NASA's Huntsville, Ala., facility, and $81 million will be for other research and development work. Salaries and expenses connected with Saturn at Huntsville will be $34.3 million. Construction and equipment will cost $13 million, including test facilities at Huntsville and launch pad work at the Atlantic Missile Range. Total Fiscal 1961 NASA spending at Huntsville for Saturn will be $56.7 million.

NASA's total budget for its new Huntsville facility is $92.3 million in Fiscal 1961. This includes $18,752,000 for research and development and $18,450,000 for construction and equipment for Saturn and other programs. Salaries and expenses for Huntsville total $55,113,000. NASA's Huntsville facility will expand from 100 employes at the end of the current fiscal year to 5,500 employes by the end of Fiscal 1961.

Manned Space Budget

NASA's manned space flight budget of $107,750,000 in 1961 is almost entirely concentrated on Project Mercury research and development, and another $15 million is allocated for the Mercury tracking net which is to be completed by the end of the fiscal year. These sums will bring total Mercury spending close to the $300 million mark by the end of Fiscal 1961. About $1 million of the 1961 manned space flight budget will go for outside help in pulling together the internal NASA studies on missions beyond the initial Mercury orbital flight phase.

Project Mercury is now expected to cost about $350 million to complete the demonstration of manned orbital flight. NASA cites a variety of reasons for the increase over original estimates of about $200 million, including bookkeeping changes, cost overruns, changes in the scope of work and some mistakes NASA made in estimating costs in this new research area.

Of the research and development programs for which funds are requested, Mercury and Saturn have the highest budgets. Among other vehicle programs, Centaur funding increases from $37 million in Fiscal 1960 to $47 million, while Delta funding declines slightly from $13.3 million to $12.5 million. Scout research and development work has been completely funded, and any

National Aeronautics and Space Administration
Fiscal 1961 Obligational Estimates

(RESEARCH AND DEVELOPMENT PROGRAMS)

	FY 1959	FY 1960	FY 1960 Supplemental	FY 1961
Aeronautical and Space Research:				
Support of NASA plant	$1,097,651	$22,684,000	.....	$31,345,000
Research grants and contracts	3,028,000	4,930,000	.....	10,000,000
Support of JPL plant	8,156,500[1]	.....	.....	.....
Scientific Investigations in Space:				
Sounding rockets	3,556,170	8,811,000	.....	8,000,000
Scientific satellites	21,305,114	23,813,000	.....	41,700,000
Lunar and planetary exploration	31,882,607	49,000,000	.....	45,000,000
Vanguard	21,943,582[1]	.....	.....	.....
Satellite Applications:				
Meteorology	987,350	7,930,000	.....	20,700,000
Communications	3,574,806	3,170,000	.....	5,600,000
Manned Space Flight	46,416,333	74,962,000	$12,000,000	107,750,000
Vehicle Systems Technology	1,903,651	6,737,000	.....	21,200,000
Space Propulsion Technology:				
Solid rockets	615,898	3,785,000	.....	2,800,000
Liquid rockets	15,978,589	30,328,000	.....	40,000,000
Nuclear systems technology	3,810,496	6,000,000	.....	10,000,000
Space power technology	.....	4,814,000	.....	8,000,000
Vehicle Development:				
Scout	6,048,000	2,800,000	.....	.....
Delta	12,927,417	13,300,000	.....	12,500,000
Vega	14,291,494	4,000,000	.....	.....
Centaur	4,000,000	37,000,000	.....	47,000,000
Saturn	.....	.....	.....	81,008,000
Tracking and Data Acquisition	3,095,674	16,266,000	.....	32,550,000
Total	$204,619,532	$320,350,000	$12,000,000	$545,153,000

[1] Funded under program activities in 1960 and 1961.

money for this vehicle in the Fiscal 1961 budget will come from the budgets of the satellites it will launch.

Along with Scout, NASA will be depending upon Thor and Atlas boosters with Delta and Agena upper stages for satellite launchings in the near future, once these vehicles are tested and proven. NASA also plans to buy two Atlas-Able vehicles in 1961.

Vehicle systems technology funding, which covers midcourse and terminal guidance and attitude control systems, jumps from $6,737,000 in the current fiscal year to $21.2 million next year. Increased costs of tracking and data acquisition are reflected in a doubling of that budget to $32,550,000 in Fiscal 1961.

NASA has budgeted $2.8 million for solid rocket work and $40 million for work on such liquid rockets as the 1.5 million lb. thrust F-1 engine during the coming fiscal year. Space power technology will be funded for $8 million in Fiscal 1961, and nuclear rocket work is allotted $10 million, which will be matched with $26 million from the Atomic Energy Commission budget.

In the field of scientific investigations in space, sounding rocket activity is budgeted for $8 million, about the same level as this year. Scientific satellite allotment increases from $23.8 million to $41.7 million. Formal budget allotments for lunar and planetary exploration decline from $49 million this year to $45 million in Fiscal 1961, but much of the $11 million transferred to this account after Vega was canceled will actually be spent in Fiscal 1961.

NASA devotes an estimated 25% of the work effort at its three research centers to aeronautical research, and all research of this type is now done in these centers. Relatively small effort is planned in Fiscal 1961 on problems concerning aircraft and missiles. Aeronautical work will be limited largely to problems connected with development of high speed military aircraft, short and vertical takeoff aircraft and nuclear propulsion for aircraft.

NASA Allotments

NASA has requested $89,287,000 for construction and equipment in Fiscal 1961. Allotments to each of the NASA facilities and projects to be built in 1961 include:

- **Langley Research Center,** $11,957,000; aerothermal dynamics facility for simulating hypersonic speed environments and a laboratory for study of the dynamics of objects in various density, temperature, acceleration and vibration environments.
- **Ames Research Center,** $980,000; additional equipment for a centrifuge to simulate high acceleration effects on vehicle equipment.
- **Lewis Research Center,** $9,100,000; basic materials research laboratory and a laboratory for research on energy conversion and power generation processes and equipment.
- **Goddard Space Flight Center,** $9,500,000; payload test facility, satellite systems laboratory and utility installations.
- **Wallops Station,** $4,000,000; system to determine the precise trajectory of launched vehicles, operations computing center and modernization of certain existing support equipment.
- **Jet Propulsion Laboratory,** $5,000,000; modernization of laboratory facilities, solid propellant facility, liquid propellant test cell, antenna range and acquisition of approximately three acres of land.
- **NASA Huntsville Facility,** $18,450,000; Saturn static test facility, central laboratory and office facility, dynamic test facility, addition to a fabrication laboratory, extension to an assembly building, pressure test cell and additions to the engineering and guidance and control buildings.
- **Atlantic Missile Range,** $2,550,000; completion of Saturn launch complex and addition to the engineering and laboratory building.
- **Tracking facilities** for the Minitrack net, $4,750,000; deep space net, $8,000,000 and Mercury net, $15,000,000; additional electronic and optical equipment, control and data processing equipment, and accessory equipment, shelters and utilities.

Gates Downgrades Soviet Missile Lead

By Ford Eastman

Washington—New intelligence estimates have narrowed the intercontinental ballistic missile gap between the U. S. and the Soviet Union, Defense Secretary Thomas S. Gates, Jr., said in testimony before the House Defense Appropriations Subcommittee released last week.

Gates told the subcommittee that, while earlier estimates gave the Russians a three-to-one superiority in ICBMs between 1960 and 1963, it now appears the USSR will enjoy only "moderate numerical superiority" during the next three years. He said:

"If we compare the estimated Soviet ICBM and sea-launched missile programs with plans for the deployment of U. S. ICBMs and Polaris missiles, we note that the Soviets may enjoy at times a moderate numerical superiority during the next three years. This difference in numbers appears to peak during the 1962 period. Our estimates indicate that both before and after mid-1962 the numbers are closer together."

Gates said the previous intelligence estimates were based upon Soviet capabilities; the new estimates upon what the U. S. believes Russia will do.

He told the subcommittee that numbers represent only a part of the picture in estimating relative strength and mean little unless other factors are taken into consideration. These, he said, include the warning time involved, relative hardening of bases, dispersal, mobility, reliability and accuracy.

Because of these additional factors, Gates said he does not believe Russia will risk all-out war merely on the basis of numerical superiority in ballistic missiles. He said the matter has been studied in detail and that it has been concluded "that even a surprise attack by all the missiles the Soviets could muster would not suffice to destroy enough of the U. S. retaliatory strike forces to enable him to make a rational decision to attack." He added:

"We have estimated the performance characteristics, such as accuracy, reliability and warhead size which Soviet missiles may be expected to exhibit during the period. While in many respects Soviet missiles have characteristics similar to our own, the analyses indicate that their accuracy will be inferior to ours.

"The significance of this simple numerical comparison to our deterrent posture depends greatly upon the accuracy which the Soviets may attain with the missiles. This is so because the number of relatively inaccurate missiles required to destroy a hardened military target, such as an ICBM emplaced in a concrete silo buried in the ground, is considerably greater than the number of highly accurate missiles required to do the same job."

Gates said the Defense Department also has examined the relative positions that would exist if the Soviets elected to produce and deploy more missiles than estimated and if their performance exceeds what the U. S. believes it will be. These analyses show, he said, that even under such circumstances, the resulting difference in numbers should not enable the Soviets to gain a strategic posture that might tempt them to initiate a surprise attack.

"This conclusion," he said, "is based on the knowledge that our over-all deterrent posture depends not only on our long-range missile capability but also upon the continued success of other strategic weapons development programs, including those for mobile systems; upon the continued evolution and refinement of our capability to mount a sustained air alert on short notice; upon our ability to bring advanced early warning systems into operation; and upon our continued vigilance in detecting and reacting to improvements or changes in the Soviet posture, intentions and weapons developments."

Research and development effort on Army's Nike Zeus anti-missile missile system has been greatly accelerated during the last two years, Gates said. He added, however, that the technical problems involved in detecting, tracking, and computing the course of an incoming ballistic missile and guiding the intercepting missile to its target are still staggering.

"Our knowledge of ballistic missile defense is still limited and we are not sure that we have identified all of the problems which such a system would have to solve," Gates said. "This year's money ($300 million), as I understand it, will pay the costs of the full-scale tests that we envision conducting in the Pacific. That will give us a great deal more technical data for where we go from there. I think by that time we will have enough information to make up our minds whether or not to go into production."

The Nike Zeus system, he added, "has serious problems about it. One is that it is a point-defense system. It is an extension of what might be called the Nike Hercules type system. You have to put a lot of them around the United States, around Strategic Air Command bases, or around cities, at a cost of maybe $14 or $15 billion. You might be able to protect, if it worked, a certain percentage of the population of the United States. . . . I do not want to downgrade it before we give it its fair chance because it is the only anti-missile system we have that looks promising."

In addition to Nike Zeus, Gates said, basic research and development effort has been accelerated on Advanced Research Projects Agency's Project Defender to explore all the phenomena associated with missile flight that might be useful in solving the missile defense problem and to examine the possibilities of applying other techniques to detection, discrimination, interception and kill.

Other highlights by Gates included:

- **"For the satellites** we are working on for reconnaissance purposes, or warning purposes, or other military purposes that we have in mind, we have no requirement for the kind of thrust in rocket engines that is needed to make the type of shot the Soviet Union made to the moon. We have no present military requirement for the use of space that we cannot handle with the present ICBM boosters or a slight augmentation of them.
- **Further studies** of the air defense problem are being made in which the continued use of aircraft interceptors in numbers is being considered. "One of the reasons for this," Gates said, "is that the (Boeing) Bomarc sites themselves are vulnerable, as fixed sites, to good accurate missiles.
- **"We have not yet established** the force levels for the Minuteman or Polaris. So, we are in the position where we could overprogram if we were unwise, but, at the moment, we probably would hope to program faster in those two weapons if we were sure of them technically. I think from the standpoint of what is required we will just have to review that on an annual basis, watching to see what the Russians really do."

New IRBM Proposal

Washington—Proposals for development of a second generation intermediate range ballistic missile for the North Atlantic Treaty Organization are under Defense Department study, Defense Secretary Thomas S. Gates, Jr., said last week.

Gates said such a missile might be a land-based, mobile, Polaris-type missile for deployment in Europe. Gates added that such a weapon also might be deployed in the Far East.

In a related area, Gates told the House Defense Appropriations Subcommittee that the U. S. had dropped tentative plans to base any IRBMs in Greece.

Space Technology

Soviets Plan Biological Satellite Firings

By David A. Anderton

Nice, France—The next step in Russia's space science program will be a broad investigation of the cosmic radiation problem in preparation for manned space flight.

Russian scientists plan to send plants and "highly organized living beings"—presumably animals which possibly would be primates—into space in a series of satellites studying the effects of cosmic rays on living organisms and possible methods of protection against cosmic radiation.

These experiments are part of a general program of space research outlined by academician A. A. Blagonravov in a USSR report to the meeting here of the Committee on Space Research (COSPAR) of the International Council of Scientific Unions (ICSU).

Blagonravov defined three areas where Russian scientists will concentrate on space experimentation:

- **Upper atmosphere** of the earth and circumterrestrial space by means of artificial earth satellites. The major portion of this work will be a comprehensive study of cosmic radiation.
- **Lunar exploration** and studies in the vicinity of the moon. "We plan to continue studying the moon," said the Russian scientist.
- **Other planets** of our solar system, beginning with Mars and Venus. "Instruments brought into immediate proximity with the surfaces of other planets will permit, in the near future, solution of one of the mysteries of the world—the existence of life on other planets," the report stated.

Blagonravov's report was one of a series submitted by member nations of COSPAR summarizing work during the International Geophysical Year (IGY) and its time extension called International Geophysical Cooperation (IGC).

The Russian report said 175 investigative rockets were launched to study the upper atmosphere between July, 1957 and December, 1959—158 meteorological rockets and 17 geophysical probes. Three earth satellites and three space probes launched during the same time interval completed the Russian contribution to space science during IGY and IGC.

Meteorological rockets were fired from Russian territory in the north Arctic circle, in the central latitudes of European Russia and from ships in the Southern Hemisphere and northern Pacific. More than one-third of the firings were from a high latitude observatory in Franz Josef Land (a group of islands 80 deg. north latitude almost due north of Murmansk), a similar portion was fired in European Russia and the remainder from the diesel-electric ship "OB" of a Russian Antarctic expedition.

All 17 geophysical probes were fired from European Russia and covered an altitude range between 62 and 292 mi. These included:

- **Six rockets** which carried 810-lb. payloads each consisting of a sealed, spherical self-orientating container and instrumentation to record atmospheric structure, to make optical observations and to record ambient parameters inside and outside the container. Orientation of the container made possible geophysical measurements requiring either definite orientation of instruments in space or precise knowledge of their orientation.
- **Seven rockets** carried 4,850 lb. payloads each to an altitude up to 131 mi. Payload comprised two containers of instruments, a hermetically sealed cabin with test animals, a detachable head

Canadair CL-41 Trainer Makes First Flight

Canadair CL-41 side-by-side jet trainer makes its first flight from Cartierville Airport near Quebec (AW Jan. 18, p. 35). Flight lasted 70 min. and was limited to 15,000 ft. altitude and 320 mph. Two prototypes, powered by Pratt & Whitney JTC12-A turbojets of 2,900 lb. thrust, have been built. Ceiling is 44,500 ft. and top speed is 475 mph.

section of the rocket itself and a parachute recovery system.

• **Four rockets,** stabilized throughout flight, carried 3,300-lb. payloads to heights of about 285 mi. Launchings were made in 1958. Payloads included both instrumentation and experimental animal subjects. One clue to the workability of the parachute recovery systems of these rounds and those listed above is given in a Russian report which says "On Aug. 27, 1958, the head section with the scientific apparatus and the animals safely landed for the first time from an altitude of 450 km. (280 mi.)."

There is a discrepancy in Blagonravov's report which remains unexplained. The total number of firings with experimental animals seems to be 11 from the tabulation above. But another tabulation in the report lists nine firings only of rockets with animals—two during 1957, five during 1958 and two during 1959.

Vague Timetable

Those observers who looked for specific details in Russia's future plans were disappointed. The plans were vague and lacked the specificity of either French or U.S. reports.

Example: Blagonravov said ". . . we plan to launch a series of satellites." The French report said 20 Veronique rockets would be launched and gave a timetable. The U.S. report named nine scientific satellites, two space probes, one geophysical probe, stated the launching vehicles, detailed the experiments to be done with each shot, and gave approximate timetables where possible (AW Jan. 18, p. 30).

About the only place where the Russians did lay down a specific list of studies was their elaboration of the first phase of their satellite experiments. There they said the program is vast and includes the study of ultraviolet and X-ray spectra of the sun, mapping the stellar sky, photography of the solar corona and various nebulae, cosmic ray studies, studies of the terrestrial magnetic field and its relation with solar activity, studies of the ionosphere, the degree of ionization and its composition, propagation of radio waves through the ionosphere, studies of the gravitational field of the earth and establishment of a high-precision time service for astronomical purposes. Here they also mentioned a broad study of cosmic radiation as a preparation for manned space flight.

Blagonravov said a new field in celestial mechanics was opening as part of this work. "For the first time in the history of astronomy, calculations are made of artificial celestial bodies, including such unusual bodies as those which are able actively to influence the character of their motion." This claim is not exclusive with the Russians; any nation working with mathematics on the motion of artificial satellites is doing so for the first time in the history of astronomy.

ACF Merges Divisions

Washington—ACF Industries, Inc. has merged its Avion and Nuclear Products-Erco divisions to form a new ACF Electronics Division. The company's former ACF Electronics operation at Alexandria, Va., which produces electronic modules and capacitors, "has been placed under the jurisdiction" of the new division, according to ACF, but reportedly will soon be sold to Illinois Tool Works of Chicago (AW Jan. 4, p. 27).

New ACF Electronics Division includes plants at Riverdale, Md., and Paramus, N. J., and the recently opened Electro-Physics Laboratory in Bladensburg, Md. George B. Shaw is general manager of the new division, with headquarters in Riverdale. Robert Young is assistant general manager with headquarters in Paramus. Richard F. Wehrlin, former Avion president, has resigned to enter business in Europe.

Navy Designs New Type Radar To Detect Low-Flying Aircraft

Washington—New type radar that operates in the high frequency band and may be capable of detecting low-flying aircraft and submarine-launched missiles at distances of more than 2,000 mi. has been developed by the Naval Research Laboratory.

An experimental installation near Washington reportedly has been able to detect missiles fired from Cape Canaveral, Fla., some 900 mi. away. A $4 million prototype installation at Chesapeake Beach, Md., is scheduled for operation late this year. The program is called Project Madre, an acronym derived from Magnetic Drum Receiving Equipment.

The new NRL radar operates in the same 3-to-30 mc. HF band normally used for long-range radio communications. These frequencies bounce off the ionosphere and back to earth unlike microwaves and ultra high frequencies (UHF) normally used for radar, which are limited to line-of-sight ranges.

The HF frequency band is the same one used by Project Teepee, a missile launch detection technique developed by the Office of Naval Research (AW Aug. 17, 1959, p. 33). An inherent and serious limitation of any radar or other detection system operating in this band is the fact that HF propagation quality varies with the time of day and year and often is blacked out by auroral activity. The HF band also is relatively easy to jam.

The Rome Air Development Center constructed an experimental radar operating in the HF band almost a decade ago. The idea, however, was not carried beyond this stage because of performance limitations and the existing state of the art at that time.

Naval Research Laboratory has applied recently-developed cross-correlation data processing techniques and employs the doppler shift produced in the returning radar echo to detect the weak signal from a moving target signal in the presence of atmospheric noise and echos from the ocean. The magnetic drum, produced by General Electric Co., is used to store a series of signal returns for subsequent cross-correlation.

The Project Madre installation at Chesapeake Beach reportedly will employ a transmitter capable of delivering five megawatts peak power with a pulse repetition rate of about 200 per second. The antenna, measuring approximately 330 ft. long and 150 ft. high, will be located on a cliff overlooking the Atlantic Ocean.

The antenna will provide an azimuth beamwidth of six to 12 deg. depending upon the specific operating frequency, with an elevation beamwidth of about 12 to 24 deg. At a range of 1,000 mi., the antenna will illuminate an area that is 125-to-250 mi. wide. System is expected to be able to resolve target distance to within approximately 10 mi., target azimuth position to within about one-half a beamwidth, perhaps better.

To provide integration time for cross-correlation of target return, the antenna will look at a given area for approximately 20 sec. before advancing to the next scan position. Scanning will be accomplished by controlling the phase of the electromagnetic energy fed to the antenna elements.

To make the system insensitive to movement of the ionosphere itself and the ocean waves, it will be gated so as to detect only those targets whose speeds exceed approximately 50 mph. Unless tests indicate that this limit can be lowered, the Project Madre radar does not appear suitable for detecting surface vessels or surfaced submarines. To achieve accurate target range determination, it will be necessary to make radio soundings to establish the height of the ionosphere, an NRL spokesman says.

Martin Proposes Nuclear Rocket Plan

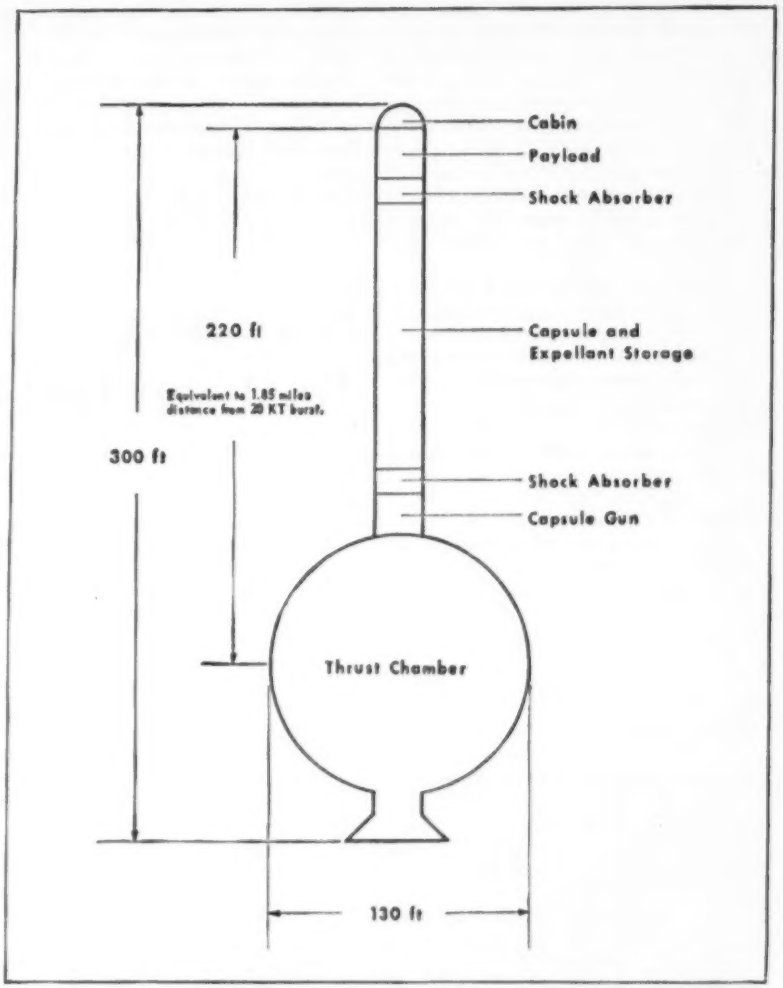
By Michael Yaffee

New York—Nuclear pulse rockets powered by repeated explosions of small nuclear bombs inside a spherical thrust chamber may be the key to economic and efficient space exploration.

Early this year, the Martin Co. will submit a proposal to the Advanced Research Projects Agency for a feasibility study of using nuclear explosions to propel space vehicles. Although the basic idea already is under study by General Atomics Division of General Dynamics in Project Orion (AW Oct. 5, p. 123), Martin scientists believe their approach is sufficiently different from Project Orion and significant enough to warrant another government program in this area.

The basis for the proposal will be three types of nuclear pulse rockets which physicist Dandridge M. Cole of Martin-Denver described at the annual meeting here last week of the American Astronautical Society. All three rockets depend, as does Project Orion, on nuclear explosions for their primary propulsion.

Throughout his study, Cole stressed the fact that his work to date was theoretical and that accurate performance data could come only from actual tests. But given even moderate assumptions, Cole said, the most primitive of his three nuclear pulse rockets—Model I—could carry twice the payload of a chemical rocket of the same gross weight. It also could equal the performance of a solid core fission type rocket, such as Project Rover, of the same propellant fraction (0.65), and same specific impulse (930 sec.) and at the same time provide a much greater performance potential, possibly up to a specific impulse of 3,000 sec.



MODEL I nuclear pulse rocket, one of three under study by the Martin Co., would be propelled by the contained explosions of small nuclear bombs and the ejection of water or some other inert expellant. Its initial gross weight would be 3.52 million lb., including 350,000 lb. of payload and 2.06 million lb. of water.

Rocket Economics

To be economically attractive, Cole said, nuclear pulse rockets must be very large, in the millions of pounds, or about the same size as gaseous core fission systems and other proposed advanced nuclear propulsion systems. The advantages of the pulse rocket, in comparison with some other nuclear systems, are that it can have far higher average thrust chamber temperatures because the heat is not carried through the thrust chamber wall and that it requires no magnetic containment.

First of the three pulse rockets described by Cole is based on a conservative design with emphasis on feasibility and simplicity. Free-space operation is assumed in order to avoid earth takeoff problems, such as atmospheric contamination, although Cole is confident that this problem will be solved with the development of clean nuclear bombs.

The Model I nuclear pulse rocket, as described by Cole, is 300 ft. long and has a spherical thrust chamber 130 ft. in diameter and weighing 1 million lb. Steel walls of the thrust chamber are 0.5 in. thick. Gross weight of the rocket is 3.52 million lb. and includes 2.06 million lb. of water and 350,000 lb. of payload.

Mission velocity of the Model I pulse rocket is 26,000 fps./sec. Leaving a minimum earth orbit with this velocity change capability, the vehicle could make a soft moon landing and then return to an earth orbit or it could travel on fast orbits to the nearer planets.

With some modification, Model I could travel from the surface of the earth to a minimum earth orbit, according to Cole. Or, he added, it could be boosted into a velocity of 8,000 fps./sec. and an altitude of 150 mi. by a cluster of nine F-1 (Rocketdyne's 1½-million-lb. thrust liquid engine) chemical rocket engines. From this point, it could go into orbit under its own power.

Propellant for the Model I nuclear pulse rocket consists of small energy capsules (0.01 kiloton nuclear bombs) and an inert expellant contained in a storage area above the thrust chamber. Between the chamber and storage area is a low velocity compressed air gun which shoots the energy capsules into the thrust chamber. Possibly, Cole says, some existing, off-the-shelf solid propellant rocket such as the Genie

could be used to carry the capsule into the thrust chamber.

A time or setback fuze could be used to make sure the capsule explodes when and where desired within the thrust chamber. The frequency of the detonations will be determined by the mission. At a frequency of one pulse per second, Cole said, the average thrust would be 800,000 lb. and the thrust-to-weight ratio would be 0.25. Higher values could be obtained for short periods by increasing the pulse frequency.

In his design, Cole assumes that water is used as the inert expellant and that the expellant also is used in the transpiration cooling of the thrust chamber walls. For each pulse of the rocket, 858 lb. of water would be used. Using a total of 2,400 0.01 kiloton bombs and 2.06 million lb. of water and assuming that 40% of the bomb energy is converted to kinetic energy of exhaust, Cole calculates that the liquid propellant version of Model I is capable of accelerating a 350,000-lb. payload through a velocity change of 26,000 fps./sec.

The principal problem concerning the feasibility of propulsion by contained nuclear explosions revolves on the question of whether a thrust chamber can be made strong enough to contain the explosion and at the same time light enough for acceptable vehicle performance. Cole calculates that his 1-million lb. steel thrust chamber would be more than adequate.

Shock transmission from thrust chamber to payload should be significantly less than in the external explosion system where the entire impulse is directed against a shield at the rear of the vehicle, according to Cole. The problem of shock transmission in the Model I nuclear pulse rocket, he says, can be solved by making the thrust chamber wall in two concentric shells and filling the intervening space with a compressible shock absorbing gas and by building a shock absorbing system between the thrust chamber and the rest of the vehicle.

Heating problems, Cole says, can be controlled by a combination of bomb wrapping and transpiration cooling.

Assuming that bomb costs will drop to $100,000 per bomb in the future—or possibly even to $10,000—Cole estimates that propellant costs would range from $70 to $700 per pound of payload for his Model I nuclear pulse rocket.

In his proposed Model II nuclear pulse rocket, based on design assumptions which seem reasonable for 10 or 20 years in the future, Cole reduces the factor of conservatism in the weight of the thrust chamber from 20 in Model I to a factor of 4. The spherical steel thrust chamber is still 130 ft. in diameter but now weighs 200,000 lb. instead of 1-million lb.

Including expellant costs ($5 per lb.) as well as energy capsule costs ($10,000 per unit), Cole obtains a total propellant cost for his Model II nuclear pulse rocket of $25.80 per pound of payload. This figure is based on the following parameters, assumed and calculated: exhaust velocity, 37,200 fps./sec. (specific impulse equals 1,150 sec.); propellant fraction, .90; kinetic energy per pulse 1.2 x 10^{10} ft./lb.; payload, 2.92 million lb.; gross weight, 6.72 million lb.; number of pulses, 5,800; expellant mass per pulse, 558 lb.

Even more economically attractive is Cole's Model II-A, a larger version of Model II which uses 0.1 kiloton energy capsules. The Model II-A thrust chamber is 282 ft. in diameter and weighs 2 million lb. Capsule and expellant costs remain respectively $10,000 per unit and $5 per pound. Gross vehicle weight is 67.2 million lb. and payload 29.2 million lb. The resultant total propellant cost for Model II-A is $7.90 per pound of payload. If Model II-A were to be redesigned instead of simply scaled up from Model II, Cole believes it would be possible to obtain a propellant cost of $6.50 per pound of payload.

Considerably different, Cole's Model III vehicle is a nuclear pulse jet, not rocket. Energy source would still be contained nuclear explosions but the expellant would be air taken from the surrounding atmosphere. Principal mission of this nuclear airbreather would be transportation of payloads from earth to near satellite orbits.

NATO Chooses Breguet 1150 ASW Aircraft

Paris—United States and four NATO nations will jointly finance and produce the Breguet 1150 Atlantic twin turboprop anti-submarine aircraft.

The Breguet aircraft a year ago won a NATO competition for a standard ASW aircraft (AW Dec. 15, 1958, p. 35). First of two prototypes already under construction is expected to fly toward the end of 1961. The Atlantic, powered by two Rolls-Royce Tyne turboprops, is slated to replace 200 NATO Lockheed P2Vs.

Nations involved in financing in addition to the U.S. are France, West Germany, the Netherlands and Belgium. U.S. funds will come out of its Mutual Weapons Development Program (MWDP).

The five nations will assume responsibility for the supervision and financing of the project. Over-all management of the program will be handled by a special steering committee. Construction work will be done under the executive supervision of the French Air Ministry's Technical and Industrial Section (DTI).

Construction both at prototype and production stage will be shared by a consortium of five West European companies: Breguet and Sud Aviation in France, Dornier in West Germany, Fokker in the Netherlands and ABAP in Belgium. Latter group represents three Belgian companies, SABCA, Avions Fairey and Fabrique Nationale d'Armes de Guerre (FN).

Engines for the two prototypes will be supplied by Rolls-Royce while much of the electronic equipment will come from the U.S. However, West European companies may eventually build engines and electronic equipment for the Atlantic under license.

The Atlantic is a midwing land-based aircraft carrying a crew of 12. Span is 124 ft. length, 90 ft.; height, 35 ft. Wing area is given at 1,292 sq. ft. and gross weight 86,000 lb.

Soviet Manned Satellite

New York—Russia will launch a manned satellite by late spring or early summer in the opinion of Brig. Gen. Don Flickinger, director of life sciences, Air Research and Development Command.

Flickinger believes the Pacific area, recently designated by the Russians for missile impacts, will be used by Soviet scientists for water recovery of their manned satellites.

Gen. Flickinger pointed out at the annual meeting of the American Astronautical Society that the location of the Pacific impact area was a likely spot for a Russian satellite to come down if the re-entry signal were given at a Siberian command station. It seems unlikely, he said, that the Soviet would reserve this area simply to put on a public demonstration of the accuracy of their missile guidance systems.

When they do launch a manned satellite, Gen. Flickinger believes that it will be announced as a scientific experiment and not simply as the fact that they have put a man in space. The satellite will probably be a two-man vehicle, he said, because this will create a greater impact from the viewpoint of prestige. Also, two men have a greater safety factor than one; and, in light of the Russians' publicly announced concern with the safety aspect of such an undertaking, this could be an important consideration.

USAF Tightens Rules Defining Industry, Retired Officer Relations

By Katherine Johnsen

Washington—Air Force quietly issued a seven-page regulation designed to preclude possible industry influence in the actions of USAF officers on the opening day of Congress, it was disclosed in testimony released last week by the House Appropriations Committee.

The new regulation enlarges the scope as to what constitutes "selling" by former officers employed by contractors, requires them to register with the Air Materiel Command, and warns officers on active duty against accepting favors or gifts from industry that might even be "interpreted" as improper.

Defense Secretary Thomas S. Gates, Jr., apparently was unaware of the USAF action when he appeared before the committee on Jan. 14. Queried as to whether any regulations had been adopted prohibiting Defense officials and officers from accepting favors from contractors as a result of extensive hearings last summer by the House Armed Services Investigating Subcommittee headed by Rep. Edward Hebert (D.-La.), Gates replied:

"We have adopted them in conversation. We have no written regulations. We have been waiting to discuss this with Mr. Hebert's investigating committee. . ."

Gates also staunchly defended the Bahamas entertainment of top Defense officials by the Martin Co. (AW Dec. 7, p. 25) following a suggestion by Rep. Jamie Whitten (D.-Miss.) that it was tied to continuation of the Martin Mace missile program by the Air Force. Whitten asked:

"Were these trips made in an effort by Martin to prevent the Congress from insisting on putting off procurement contracts until the missile was proved, or do you know?"

Gates replied that, "I know that it had no bearing on the Mace contract."

Air Force request for $127.5 million for Mace in the Fiscal 1960 budget, was refused by the House Appropriations Committee on the grounds that Mace is obsolescent. Senate Appropriations Committee turned down USAF's request to restore the funds, but added a proviso that funds could be diverted from other projects to Mace if it is considered "essential." USAF has transferred $125 million to Mace for Fiscal 1960.

The record of the Hebert subcommittee shows two trips to the Bahamas sponsored by the Martin Co. during the period Mace was being disputed in Congress:

• **USAF Maj. Gen. James Ferguson** was a guest of the Martin Co. at the Cotton Bay Club in the Bahamas, Jan. 10-17, 1959. At the time, Gen. Ferguson was director of requirements in the office of the deputy chief of staff for development. Gen. Ferguson, now vice commander of the Air Research and Development Command, presented USAF's policy statement in support of Mace to the House Appropriations Committee on Feb. 16.

• **Gen. Nathan Twining,** chairman of the Joint Chiefs of Staff, and two active Air Force generals—Gen. S. E. Anderson and Gen. Emmett O'Donnell, Jr.—were Martin guests at Cotton Bay Feb. 26-Mar. 1. At the time, Gen. Anderson was commander of ARDC. Gen. O'Donnell at the time of the trip was deputy chief of staff, personnel. He became commander-in-chief, Pacific Air Forces, in August.

Other developments last week indicative of the interest in Congress on industry-military relationships include:

• **Rep. Hebert—introduced** legislation banning former officers and civilian officials from "selling"—be it a concept or hardware—to the defense establishment for a period of two years after leaving government service (AW Jan. 18, p. 26). Rep. Carl Vinson (D.-Ga.), chairman of the Armed Services Committee, said hearings will be held "as soon as possible" and that the measure would be passed at this session of Congress. The hearings are expected to be brief.

• **House Appropriations requested** Defense Department to supply a list of the 10 largest defense contractors showing the volume of defense business they have received over the past five years and the change in the market value of their stock that has occurred in that period.

Soviets Test Rocket

Washington—Soviet Russia last week fired the first of its "more powerful" space rockets more than 8,000 mi. from a new site near the Aral Sea into the Pacific Ocean. U. S. Defense Department said the rocket "apparently did fall within the impact area" described by Russia on Jan. 8, and Russia claimed the "nose cone of the last stage of the rocket, designed to pass through the dense layers of the atmosphere," fell within 1.24 mi. of the "predetermined point."

Impact was registered by radar, optical count and acoustic devices aboard the three 3,800-ton Soviet tracking ships Sibir, Suchan and Sukotkah. Rocket carried telemetry and was "also used to check performance of certain scientific instruments and to make required measurements," Russia said.

New launch pads are located on an island in the mouth of the Amu O Dar'ya River, which empties into the Aral. All three Soviet ships carried tracking gear and one carried large cargo booms that might be used for nose one recovery. All had what appeared to be helicopter landing pads at their sterns and what appeared to be small, high-frequency radar antennas, possibly to help in pinpointing nose cone impact by means of a transponder in the cone.

Mercury Test Launch

Wallops Station, Va.—Boilerplate Mercury capsule carrying a 6 lb. monkey was launched here last week in a test of the Mercury escape rocket system under high aerodynamic loads.

Capsule was separated from the booster at 36,500 ft. and recovered by helicopter after its parachute system lowered it into the Atlantic 12 mi. from the launch site. The female monkey, Miss Sam, was alive and apparently in good condition when checked immediately after landing and before being flown to Brooks AFB, Tex., for detailed examination and study.

News Digest

Douglas Aircraft Co. reported a $33,822,000 deficit for its fiscal year ending Nov. 30 on sales of $883,884,000. Backlog at year's end was $1,317,277,000 compared with $1,544,000,000 a year earlier.

British European Airways team headed by Lord Douglas of Kirtleside, BEA chairman, visited Sikorsky and Vertol last week to look at the turbine-powered Sikorsky S-61 and Vertol 107 helicopters. The airline may buy one of these types for such possible short haul routes as Penzance to the Scilly Islands in southwest England, a route now served by de Havilland Rapide 16-passenger fixed-wing aircraft.

Scandinavian Airlines System Sud Caravelle twinjet transport crashed into a hilltop last week during an approach to Ankara, Turkey, airport. None of the 42 persons aboard survived.

Dr. Guy Suits is vice president and director of research for General Electric Co., not Ampex Corp., as reported in last week's article on GE's new thermoplastic recording technique (AW Jan. 18, p. 87).

FAA Budget Stresses Airway Needs

Agency's Fiscal 1961 requests total $654 million; represent $143.5 million increase over this year.

By Robert H. Cook

Washington—Federal Aviation Agency is concentrating upon the staffing and expansion of its air traffic control system in Fiscal 1961 budget requests submitted to Congress last week.

Total funds of $654 million requested represent an increase of $143.5 million over the Fiscal 1960 budget and reflect FAA's early progress in carrying out plans for modernization of the nation's airways.

Of the increase over Fiscal 1960, $64.3 million is scheduled to cover the full-year costs of services initiated on a part-year basis during 1960 plus the cost of operating added facilities that should be ready during the year under previous appropriations and 4,547 new employes, most of them technicians. Addition of the new personnel would give the agency a total work force of 39,152 persons, of whom 40% will be engaged in traffic control. Another 40% will handle maintenance work, the remaining 20% administrative duties.

Major portion of the increase has been allotted to expanding air navigation facilities at a cost of $195 million, an increase of $76.8 million over the Fiscal 1960 budget allocation. Funds would cover the cost of constructing additional air route traffic control centers and airport towers, the purchase of nine aircraft for agency use and the installation of new radar equipment and other navigational aids.

Research and development funds of $65 million are being requested, an increase of $16 million over Fiscal 1960. The increase has been requested primarily to meet FAA's planned five year schedule implemented in 1957 by the Civil Aeronautics Administration for modernization of the airways.

Balance of the FAA budget estimate provides $6 million for operations and maintenance costs of Washington National Airport for the year plus costs necessary to train personnel and acquire needed equipment for the opening of Dulles International Airport near Washington by July, 1961. An additional $5 million also was requested to provide greater safety and operating efficiencies at Washington National. FAA hopes to receive authority to establish a private corporation to operate both airports through legislation that would permit all revenues earned to be applied to the operating costs of the airport and payments of interest on the government's investment in the airports.

Including the extra sum of $63 million previously authorized by Congress for aid to airports under an extension of Public Law 86-72, FAA's total new obligational authority requested would be $717 million.

Breakdown of FAA's budget figures shows that a significant part of the allocations will cover the cost of air traffic and navigation installations that have been in operation for a portion of Fiscal 1960 and those still to be added under current budget appropriations. These improvements will total $130 million by the end of Fiscal 1960.

Continuation of the expansion program through Fiscal 1961 will provide an additional 13 airport control towers, complete short range aviation units (Vortac) at 62 locations, 20 instrument landing systems, approach lighting for 89 airports, long-range radar facilities and air traffic control radar beacons at 27 locations for en route traffic, and 27 terminal area traffic control radar beacons.

In addition, this portion of the budget covers the cost of nine new transition terminal center buildings at an estimated cost of $17 million, and the purchase of the nine aircraft. The buildings will be contracted by FAA which estimates it will save $700,000 by spending its own money as compared with the past practice of leasing such facilities from private firms.

FAA has authority in the Fiscal 1960 budget for the purchase of one aircraft. With Fiscal 1961 funds, the agency plans to buy two jets for flight inspections between 24,000 and 40,000 ft. altitudes and seven other aircraft for the training of flight inspectors. No decision as to the type of aircraft models to be purchased has been made.

Funds for research and development, FAA said, are being planned around a continuation of the projects formerly handled by the Airways Modernization Board. Much of this work will be contracted to industry with experimentation and evaluation conducted at the FAA's test center in Atlantic City, N. J. FAA said only the "most compelling needs" are being included in its research program, which accounts for less than 10% of the agency's budget dollars.

Major projects the agency says it will continue to explore include automatic

Federal Aviation Agency

(Summary of New Obligation Authority Budget Estimates—Fiscal 1961)

Appropriation	1960 Appropriation	1961 Estimate	Difference
Expenses	$318,700,000	$383,000,000	+$64,300,000
Research and development	48,725,000	65,000,000	+16,275,000
Establishment of air navigation facilities	118,200,000	195,000,000	+76,800,000
Operation & maintenance, national capital airports	2,400,000	6,000,000	+3,600,000
Construction, national capital airports	.....	5,000,000	+5,000,000
Construction & development, additional Washington airport	22,470,000	.....	−22,470,000
New obligation authority included in President's budget	510,495,000	654,000,000	+143,505,000
Grants-in-aid for airports (enacted)	63,000,000	63,000,000	.....
Total new obligation authority	$573,495,000	$717,000,000	+$143,505,000
Grants-in-aid for airports (liquidation of contract authorization)	$47,500,000	$80,000,000	+$32,500,000

traffic control, joint use of automatic weather distribution information and development of an all-weather landing system.

The agency also hopes Congress will enact an airways users charge by means of new aviation fuel taxes, urged by President Eisenhower in his budget message. Based upon raising the present gasoline tax from 2 to 4½ cents per gal. plus a 4 cent per gal. levy on jet fuel, FAA estimates that the user charge would provide annual revenues of $89 million to help support the airways system—$50 million from jet operations and $39 million from piston engine aircraft.

CAB Budget

The President also took note of the increase in subsidy payments included in the budget estimate of the Civil Aeronautics Board and advised Congress that it may be necessary to consider proposals to make local-service carriers, including helicopter operators and intra-Alaska service airlines, less dependent upon government aid. Subsidy payments requested for 1961 by CAB represent an 80% increase over the payments granted in 1958, the President said.

CAB's budget request totals $76,584,000, of which $68,984,000 covers Fiscal 1961 subsidy estimates. Salary and expenses estimated increased $675,000, while predicted subsidy payments were calculated at $10,484,000 above the $58.5 million expected for Fiscal 1960. Subsidy payments for Fiscal 1959 totaled $54,844,500, reflecting the expense of operating new equipment and inaugurating service over new routes.

Under the proposed 1961 budget, $57.4 million in subsidy will be paid 13 local-service carriers as compared with expected payments of $53.4 million for 1960. Three helicopter operations will collect $4.7 million under the new budget, and seven Alaskan airlines will be paid $9.3 million in subsidy for Fiscal 1961. Most of the $1.7 million increase in the Alaskan carriers' subsidy needs reflect retroactive adjustments for prior years' operations since the airlines operate under temporary mail rates subject to periodic review.

Sayen Charges FAA Program Causes Pilot 'Resentment, Anxiety'

By L. L. Doty

Washington—Clarence N. Sayen, president of the Air Line Pilots Assn., charged last week that the Federal Aviation Agency's enforcement program has resulted in "resentment and anxiety" among pilots who believe they are being asked to replace "good judgment" with "arbitrary laws" in flight operations.

Testifying before a Senate Aviation Subcommittee headed by Sen. A. S. Mike Monroney (D.-Okla.), Sayen said in a 42-page prepared statement that the FAA enforcement philosophy, "while well-meant," is not achieving "its over-all safety objectives." Flanked by 10 veteran pilots at the witness table in the Senate hearing room, Sayen frankly criticized the agency's policies in this and other areas but presented his case in a manner that provided the subcommittee with a detailed documentation of the airline pilots' stand on safety issues.

Area of Investigation

The Senate subcommittee, which earlier heard FAA's side to the air safety problem in testimony by its Administrator, E. R. Quesada (AW Jan. 18, p. 37), is investigating airline safety, pilot certification, air traffic control, airspace requirements and military participation in the FAA.

Here are the major points raised by Sayen in his testimony:

• **Terminal area facilities.** Sayen charged that the accident record for 1959 bears out the fact that development of air terminal facilities has "lagged badly behind the development of aircraft." He called this deficiency "one of the most critical problem areas in aviation today" and noted that during 1959 36% of the year's air carrier accidents and 37% of the fatalities occurred during approach or landing operations. During 1959, there were nine airline accidents in which there were fatalities at the cost of 212 lives.

• **Rescue facilities.** The ALPA chief told the subcommittee that a lack of standards and overlapping authority have seriously impaired installation of proper fire fighting and rescue facilities at many fields. He said there is no published information available to pilots as to what rescue facilities can be expected to aid in an emergency landing and, in an aside to subcommittee members, said, if possible, "most pilots would head for the nearest military airport" where adequate fire fighting and rescue facilities can be counted on in the case of an emergency.

• **Air traffic control.** See-and-be-seen is still the primary system for prevention of midair collision, Sayen said. He added: "We continue to urge that FAA extend positive separation procedures to all aircraft operating above 10,000 ft. as soon as possible."

• **Pilot training.** Referring to ALPA's cockpit "fail-safe concept," Sayen said: "It is imperative that he (the captain) have well qualified and carefully coordinated assistants and that any incapacitation of a crew member leave at least a minimum crew in full control." He said his union has urged regulatory action in the pilot training area and, while admitting that FAA had adopted rules requiring airlines to submit their training programs to FAA for approval, he noted that the regulation establishes no standard for such programs. He urged maximum use of flight simulators in training programs.

• **Copilot proficiency.** Sayen supported FAA's recently proposed regulation that would require copilots to be type rated and to demonstrate proficiency every six months. He said, however, that the Air Line Pilots Assn. felt this regulation was deficient in that it failed to increase licensing requirements for copilots as recommended earlier by the union.

• **Rule making.** Sayen charged that failure of the Federal Aviation Act of 1958 to provide for the right of appeal to the Civil Aeronautics Board on rulemaking decisions by the FAA has enabled the administrator to become "a complete czar over the entire aviation industry . . ." Earlier, J. B. Hartranft, Jr., president of the Aircraft Owners and Pilots Assn., testified that the lack of a system "of checks and balances and adequate appeal machinery that will afford an impartial hearing for a pilot" needs clarification.

Recent Accidents

Sayen gave his testimony against a backdrop of two air carrier accidents registered thus far this year that have taken a toll of 84 lives. Last week, a Capital Airlines Viscount crashed near Richmond, Va., on a scheduled flight from Washington to Norfolk killing 46 passengers and four crew members.

The initial facts of the crash were entered into the record of the Senate investigation.

The National Airlines DC-6B crash, which occurred earlier this month near Bolivia, N. C. (AW Jan. 11, p. 29) received major attention during the hearings. Oscar Bakke, chief of the Civil Aeronautics Board's Bureau of Safety, was brought back to the witness table to give the subcommittee the latest developments in the investigation of the accident. Bakke stated that studies of the plane showed initial damage was "localized" in the right forward section of the fuselage opposite the No. 3 engine.

Further testimony, showing that the body of one passenger—which was embedded with such foreign matter as

steel wire, brass and chips of wood—was found some 18 mi. from the point of impact of the main portion of the airplane, brought a suggestion of a bomb explosion from Sen. Monroney. Following this phase of the hearings, the Federal Bureau of Investigation joined in the accident investigation.

In his testimony, Sayen admitted that there appeared to be no single cause or trend to last year's accidents but added that they fell into two rough categories: disintegration of aircraft in the air and approach landing accidents.

On the latter point, he said that there are now 569 airline airports in the U. S. but, according to FAA planning figures for Fiscal 1959, there are only 210 air traffic control tower services, 122 secondary radar, 75 airport surveillance radar, 65 long range radar, 30 radar centers, 185 instrument landing systems, 53 approach light systems and 23 sequenced flashing light systems.

Sayen charged that some low density airports certificated for airline service have virtually no terminal area navigation, communications or landing aid facilities.

He also claimed that all research and development needed for necessary terminal facilities had been completed and added:

"While the (FAA) administrator has initiated certain research programs in this area, we believe that most of the necessary information is available on which to base any remaining decisions and that no further delay should be countenanced because of lack of decision by the government or agencies concerned."

Calling for adequate zoning approach and departure areas around airports, he said that any regulation adopted to alleviate aircraft noise should not represent a compromise with safety standards.

He said that persons are still permitted to build residential housing a few feet from active runways and added that:

"We seem to be capable of constructing thousands of miles of super highways in the country but find it impossible to secure another 1,000 ft. of concrete on marginal airport runways."

Sayen was sharply critical of the philosophy that pilots should be required to follow "the book" under all circumstances in flight operation. He said it was "flirting with death" to ask that pilots follow rigid patterns established by "desk-bound personnel" for all incidents that may arise in the operation of an aircraft. The man in control of the airplane, he said, is best qualified and trained to be the proper judge of the action that should be taken in given circumstances.

Sayen refused to respond to challenges brought out earlier in the hearings by Quesada that ALPA could not present any specific cases to back its accusation of "harassment" of pilots by FAA inspectors. He had this to say, however:

"We do not believe that it is fair to this committee to take their time to air individual grievances against the enforcement program and we will not do so. Unfortunately, more than half of a statement delivered before this committee was devoted to an attempt to paint certain groups as undisciplined and irresponsible, and many statements from which erroneous conclusions could be drawn were made. No useful purpose would be served by tediously going into each case and allegation and pointing out the errors, the erroneous assumptions, and the obvious fact that many complaints of FAA originated within the FAA itself. Nor will we recite the series of incidents during the past year which have caused airline pilots to be extremely critical of the inspection and enforcement policies of FAA."

Sayen took strong issue with the new FAA ruling to become effective Mar. 15 that stipulates airline pilots must be retired at the age of 60. He told the subcommittee that he found no air safety justification for this rule and added that no accident or incident has ever occurred which has been attributed to the age of the pilot.

Stuart G. Tipton, president of the Air Transport Assn., in testimony preceding Sayen, praised the Federal Aviation Agency as "constructive, aggressive, fast-moving and firm."

Tipton said, however, that FAA procedures governing proposed rules are issued without a "proper attempt being made to find out what effect on the industry" they will have. He admitted there is "nothing wrong" with the Administrative Procedures Act but said "bare compliance" with this act does not provide an opportunity for an exchange of ideas and information essential to sound safety regulations. His recommendations:

"Prior to the issuance of a notice of proposed rule making, the FAA should confer informally with the airlines, and others concerned, to get a better understanding of: the nature and posture of the problem—indeed, whether a problem actually exists; possible methods of solution; and the direct and indirect effect of various solutions."

MATS Cargo Plane

Washington—Military Air Transport Service is being permitted to request $50 million in Defense Department's Fiscal 1961 budget for development of a new cargo-type aircraft. Modernization of the 10-year-old fleet of MATS aircraft with gas turbine-powered cargo planes has been termed essential by its commander, Lt. Gen. William H. Tunner (AW Sept. 14, p. 41).

Pilots Protest CAB Crash Ruling

Washington—Air Line Pilots Assn. issued a strong protest last week opposing Civil Aeronautics Board findings indicating pilot error as a major cause behind the crash of an American Airlines Electra last February during final landing approach to New York's La Guardia Field (see p. 136).

CAB contention that failure of the aircraft crew to properly monitor its flight instruments was a factor in the accident which claimed the lives of 68 people (AW Jan. 18, p. 39) was attacked by the union as "grossly inaccurate in a number of respects."

According to ALPA President C. N. Sayen, union members at American also feel the report "maligned a dead pilot" and "conveniently wrote the accident off the books" rather than determining the cause which would prevent a repetition of such accidents. Sayen said ALPA will ask the CAB to reconsider a portion of the report and revise it.

In the judgment of airline pilots, Sayen said, the accident resulted from marginal weather conditions and inadequate approach and landing aids, possibly combined with "some mechanical or instrument malfunctioning" resulting in an inaccurate altitude indication.

Although the Board's accident report did not mention La Guardia's landing facilities as having played any part in the accident, the ALPA statement emphasized that Oscar Bakke, CAB director of safety, told the Aviation Subcommittee of the Senate Interstate and Foreign Commerce Committee investigating air safety that the accident probably would not have occurred had there been high intensity approach lights to the runway.

While agreeing with CAB recommendations that flight simulators be required in pilot training and that aircraft instruments undergo more intensive testing before use in operational airline aircraft, ALPA specifically objected to the Board's listing of possible misinterpretation of the altimeter and rate of descent indicator, inattentiveness and an erroneous setting of the captain's altimeter, as contributing factors.

"It is highly preposterous," Sayen said, "that three crew members with a total of 48 years experience and 47,027 flying hours among them could all simultaneously misread a basic flight instrument, not once, but several times."

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Turbofan Cargo 707, DC-8 Currently Favored by American

Washington—Turbofan versions of the Boeing 707 and Douglas DC-8 currently are in the lead in American Airlines' survey of proposals for development of a turbine-powered cargo aircraft, an airline official said last week.

American's preference for cargo planes utilizing turbofan engines and the need for an aircraft designed to incorporate mechanized loading facilities were outlined by William Littlewood, vice president-equipment research, in testimony during hearings on the Civil Aeronautics Board's Domestic Cargo-Mail Service Case.

Littlewood said American has been studying proposals for turboprop cargo aircraft from Lockheed and Canadair as well as the aft-fan versions of the 707 and DC-8 in an attempt to obtain an aircraft in the 40-60,000 lb. and 80-100,000 lb. payload ranges for intermediate and long-haul service. The airline, Littlewood said, also hopes to find an aircraft that can operate at a direct flight cost of between four and five cents per available ton-mile.

He told the Board that the three sets of specifications for the Hercules submitted by Lockheed and revised specifications for the swingtail Canadair CL-44D have failed to meet American's needs. He added, however, that both companies are continuing to refine and improve their specifications.

Littlewood told the Board that American wants increased takeoff and landing weights in its future cargo planes without the penalty of longer runway lengths that usually accompany such increases. He said the airline feels that these increases—needed to guarantee a full payload and provide sufficient flight range to assure expansion of the carrier's cargo route system—can best be realized with turbofan engines, which are capable of reducing the normal runway lengths for turbojets without exacting weight or performance penalties. Combining these more powerful engines with some form of boundary layer control, at least to the extent of jet flaps, Littlewood said, should produce the operational performance desired.

Although Littlewood did not spell out the runway takeoff or landing distances American wants, he had told CAB earlier that an improved version of the Super Hercules 207-23, with a takeoff gross weight of 200,000 lb., maximum payload of 77,400 lb. and a landing distance requirement of 8,350 ft. was "penalized by the lengthy requirement for landing."

Most current specifications for the Boeing 735 cargo plane incorporating turbofan engines and improvements in flap control cut almost 1,000 ft. from the required runway distance for a 735 equipped with conventional turbojets. Takeoff gross weight of the turbofan 735 is 315,000 lb., payload is 93,766 lb.

Littlewood, said, however, that American sees a need for a greater reduction in both takeoff and landing distances and is working with the manufacturers in a study of the problems that could be solved by incorporating boundary layer control into future turbine-powered cargo aircraft.

An economic air cargo operation, Littlewood said, also must include ground handling costs. Any aircraft which American may order must include a mechanized loading system designed as an integral part of the plane, to lower ground handling time.

Citing the disadvantage of present cargo loading methods, Littlewood told the Board that it now requires approximately one-half hour to load 10,000 lb. of freight on piston-engine cargo planes. Cargo aircraft needed by American would have a payload capacity three times that of present piston cargo planes. Without a mechanical loading and unloading system, the increased payload, Littlewood said, would triple ground handling times, decrease the designed speed advantages of turbine-powered planes, raise total costs and decrease aircraft utilization.

American Requests Convair 600 Performance Gains

New York—American Airlines has asked Convair Division of General Dynamics Corp. for a proposal to lower stalling speed and improve airport characteristics of the Model 600 jet transport.

The airline believes the four-engine aft-fan jet will more than meet its original guarantees, but would like to go beyond that performance point and bring the 600's airport requirements to the level of the Lockheed Electra turboprop.

Boundary layer control might be one way to accomplish this but American has not settled on this type of modification. Convair has asked for proposals for such a system (AW Jan. 18, p. 50).

La Guardia Airport is one aspect of American's search for an extremely flexible jet for short hauls and limited airports. The 600 will be able to operate at La Guardia, American believes, but without the operating margin the airline wants. The airport is something of a question mark because the rehabilitation now under way at the field does not include runway extension (AW Nov. 30, p. 48). Whether or not extension plans develop will affect American's long-range equipment plans for the airport. The carrier might be willing to operate there with less margin than it would like for a limited period if future lengthening could be expected.

The airline's pressure for further improvements to the 600 is not based on La Guardia operation alone. With a reduction in airport requirements generally, the airplane could take on routes hitherto considered impracticable for the jet.

Western Seeks Funds For Jets and Expansion

Western Air Lines has announced a financing program to raise approximately $21 million which will be earmarked for the purchase of turbojet aircraft, enlargement of headquarters and maintenance facilities at Los Angeles International Airport, and general corporate purposes.

The airline did not disclose the type of jet transport under consideration for purchase, nor how much of the $21 million will be used for buying the new equipment. Western has submitted proposals to the Civil Aeronautics Board in both the Southern transcontinental and Hawaii en route cases, in which it indicated use of the Convair 880 or Boeing 720.

Longest nonstop stages Western presently has are Los Angeles-Mexico City, 1,555 stat. mi., Salt Lake City-Minneapolis, 991 stat. mi., Los Angeles-Seattle, 951 stat. mi., and Los Angeles-Salt Lake City, 591 stat. mi.

The greater share of the new funds will be raised by offering stockholders the rights to purchase 200,000 shares of authorized, but unissued, common stock at a ratio and price to be determined at the time of offering.

The airline is negotiating with its present lenders, the Prudential Insurance Co. of America, the Occidental Life Insurance Co. of California and the Bank of America N. T. & S. A. for the balance of the funds.

Western's net earnings for 1959 were approximately $4,900,000 or about $4.75 a share, based on the number of shares outstanding.

The airline's board of directors declared a dividend of $.25 per share and a stock dividend of 5%.

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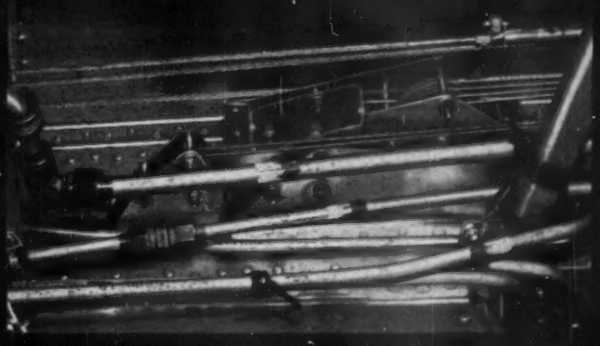

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New York Harbor Airport Site Proposed

By Glenn Garrison

New York—Maritime interests are proposing that a new jet airport be constructed closer to New York than the proposed Morris County, N. J., airport site by filling a section of New York Harbor off Staten Island. Such a project also would improve the port's facilities for shipping, proponents say.

The Port of New York Authority has been waging a battle in New Jersey to gain support for its preliminary plan for a fifth regional airport to be located in Morris County (AW Dec. 21, p. 30) and shows no interest in the Staten Island plan. Port Authority speakers were blanketing the area to get across to resistant local civic and political groups its reasons for choosing the Great Swamp site in New Jersey.

Idea of locating a new airport just off Staten Island in a shoal area now completely unused was advanced by William J. Myles, a marine equipment dealer and expert on the waters of the port. Under the plan, an airport site in the shoal would be filled with silt dredged from the harbor, and the main ship channel would be widened and deepened in the process. Two islands abandoned by the federal government and now unused would be incorporated in the filled area. Myles said the dredging would be feasible and economical.

With construction of the projected Narrows Bridge between Staten Island and Brooklyn, the airport site would be readily accessible to New York via a short causeway to Staten Island.

All approaches to the proposed airport site could be over water and an aircraft noise problem would be minimal. If feasible, such a project would seem to offer an unusual opportunity to locate a large-scale major airport almost within the environs of a huge city and at the same time avoid interference with property or community comfort.

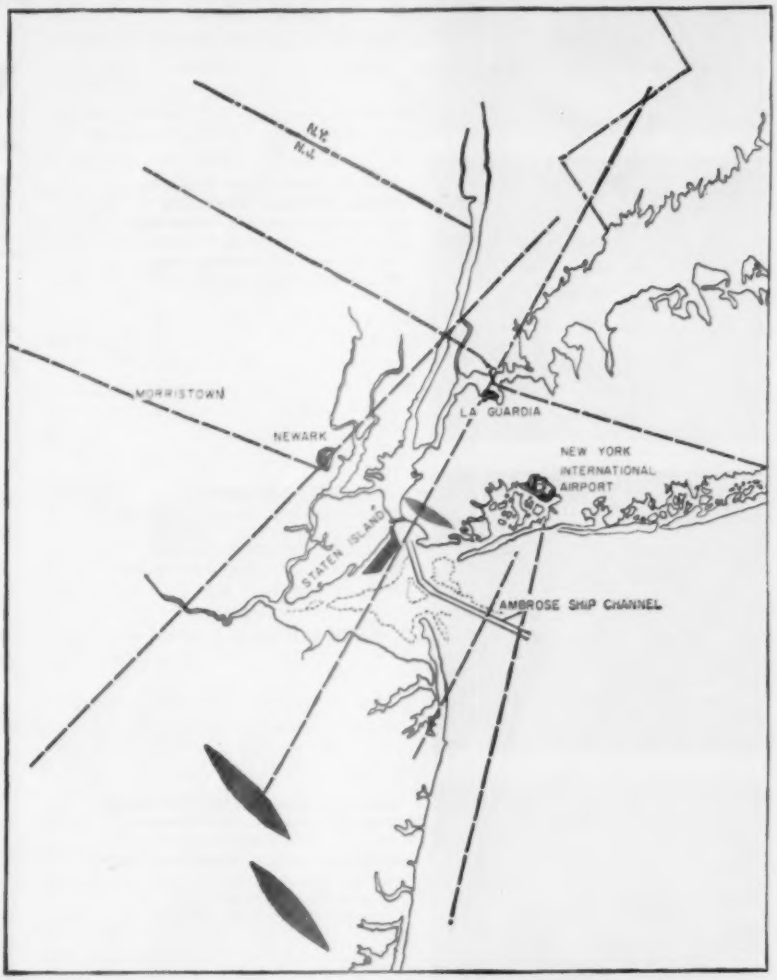
But the feasibility of the plan has been discounted by the Port Authority and the Federal Aviation Agency because of the disruption that would occur to already crowded traffic patterns in the area. Both Newark Airport and La Guardia Airport holding patterns and approaches would be invaded by traffic serving the proposed site.

The Port Authority said it had not studied the site, did not plan to because of the obvious impossibility of the traffic control situation. Operation of such an airport would require the closing of La Guardia.

But a Port Authority spokesman told AVIATION WEEK the proposal appeared practicable except from the traffic control standpoint.

The Port Authority and the airlines currently are undertaking the first phases of a $56 million rehabilitation program at La Guardia and plan to use the airport indefinitely for short and medium haul airline traffic and corporate aircraft.

Myles has the backing of at least one major business interest in the Port district. James McAllister, major towing operator in the port and elsewhere, has begun a campaign to present the proposal to various port groups. McAllister believes the project would solve the airport problem and provide additional anchorage space in the harbor.



APPROACH paths from the southwest into Newark, La Guardia and Idlewild airports are indicated above, with the La Guardia approach offering the most conflict with the proposed Staten Island airport. Other lines represent typical approach paths from other directions.

Airport Disapproved

New York—Port of New York Authority's plan to build a $220 million jet airport in Morris County, N. J. (AW Dec. 21, p. 30) was overwhelmingly disapproved last week by both houses of the New Jersey legislature. The agency needed the sanction of legislatures and governors of both New York and New Jersey before it legally could proceed with the plan.

The Port Authority will complete its definitive study of the need for another major airport in this region to handle expected traffic increases, the agency said last week. Recommendations based on this study will be submitted to the states involved later this year and if the Authority believes the project has been killed, it is expected to explain why in detail.

The New Jersey legislative resolutions disapproving the Morris County plan recommended support for another New Jersey site as the location for another airport. This site would be in Burlington County.

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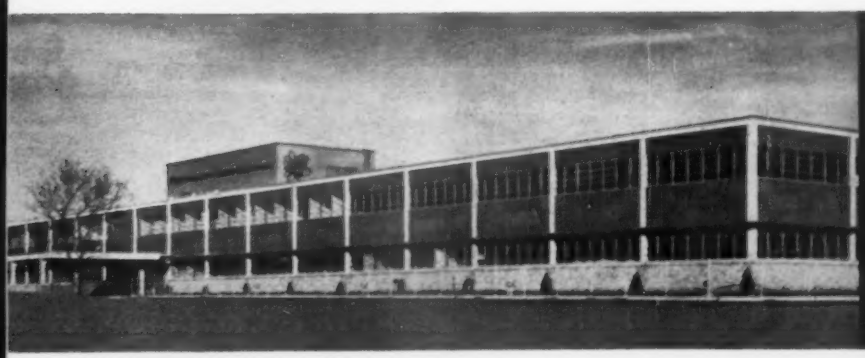

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SHORTLINES

▶ **Alitalia,** the Italian state airline, carried 39,596 passengers over its transatlantic routes during 1959 as compared with 26,425 in 1958. Cargo carried by Alitalia jumped by 129% to 1,685,725 lb.

▶ **Austrian Airlines** reports that it carried approximately 74,000 passengers during 1959, its first full year of operations, and posted a load factor of 40.1%. The European airline also reports that it had a 95% on-time record for the year.

▶ **Chicago Helicopter Airways** year-end figures show that it carried 204,393 passengers for an 87.7% increase over the previous year. CHA flew 1,990,109 revenue passenger miles, up 84.3% over 1958. The carrier posted a 50.7% load factor and completed 93.9% of scheduled mileage during 1959.

▶ **Hawaiian Airlines** carried 514,771 passengers during 1959, an 18.1% increase over the previous year. Also during 1959, Hawaiian transported 21 million lb. of air cargo between the Islands.

▶ **International Air Transport Assn.** Clearing House reports international airline business of $751,944,000 for the first nine months of 1959, 25% increase, up one quarter over the same period of 1958. Interclearances between the IATA Clearing House and the Airline Clearing House, Washington, D. C., rose 15% over the nine-month period of 1958 to $27,774,265.

▶ **Irish International Airlines** carried 578,000 passengers on its transatlantic and European routes during 1959 for a 13% increase over the previous year. Transatlantic passengers rose from 13,000 in 1958 to 23,000 in 1959. During the year, the carrier flew 10,300 tons of mail and freight and flew more than 6,289,000 mi. over its combined Atlantic and European routes.

▶ **KLM Royal Dutch Airlines** estimates that it carried 1,103,000 passengers in 1959, 142,000 more than in 1958. The Dutch carrier flew 207,000 hr. and more than 48 million mi. during the year.

▶ **Northwest Airlines'** year-end report shows that it carried 1,826,687 domestic passengers a total of 1,384,345,076 revenue passenger miles in 1959, increases of 15.9% and 24.6% respectively. The airline flew 353,776,776 international revenue passenger miles for a 1959 total of 1,738,121,852, respective increases of 18.8% and 23.4%.

AIRLINE OBSERVER

▶ **Russian aircraft designer A. N. Tupolev has told the Supreme Soviet the new Tu-124 medium-range transport made its first appearance on Russian airports late last year. Tupolev said the plane is "designed for wide use on Soviet airlines" but gave no specifications or performance figures. Earlier, the Russians said the plane will feature "more powerful engines of a new type" designed by P. A. Soloviev (AW Jan. 4, p. 27).**

▶ Increases in domestic trunkline coach traffic continued to outstrip total gains registered in revenue passenger miles during 1959. Final figures reported last week by the Air Transport Assn. show that revenue passenger miles recorded by the trunklines in all categories of traffic reached 28.3 billion for the year—a 15% increase over 1958 (AW Dec. 14, p. 39). Coach traffic for the year, however, totaled 12.29 billion for a 22% increase. First-class traffic reached 15.84 billion revenue passenger miles for a 15% increase over 1958. Coach traffic has shown consistent gains—even during 1958 when the airlines were hard hit by a traffic recession. During 1958, monthly first-class revenue passenger miles remained at about the same level of 1957 figures. As a result, the 15.84 billion revenue passenger miles shown for 1959 is only slightly higher than the 15.01 billion reported for 1957 period.

▶ **Eastern Air Lines jet surcharges proposed for New York-Miami and Boston-Miami routes have been approved by the Civil Aeronautics Board. However, proposed first-class jet surcharges on other routes, including those between Miami and Detroit, Cleveland and Chicago, were suspended for investigation on grounds that they are substantially higher than surcharges for similar jet services. The Board noted that Delta's Chicago-Miami first-class surcharge was $6 as compared with the $10 surcharge proposed for the same route by Eastern.**

▶ Ethiopia is starting the extension of runways at Addis Ababa and Asmara to 9,800 ft. as part of plans for eventual operation of jet transports by Ethiopian Airlines. Aircraft being seriously studied include the Boeing 720B and the Sud Caravelle. Study also is being given to further runway lengthening to 10,400 ft. at the two airports, which are at about 8,000 ft. elevations. Longest runway at Addis Ababa now is 5,700 ft., at Asmara 7,000 ft.

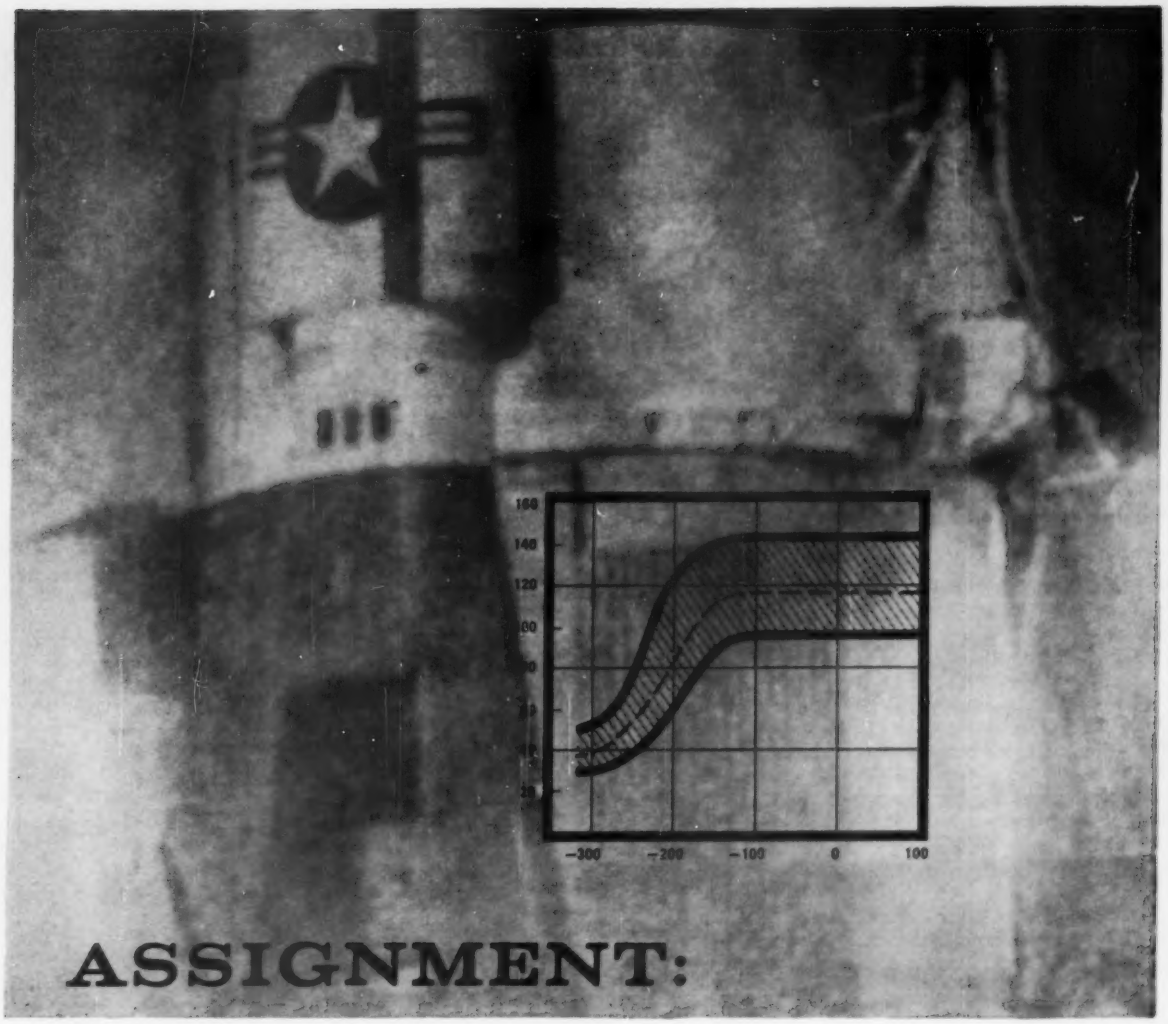
▶ **Military Air Transport Service has awarded $1.5 million in contracts to six airlines for the transportation of Defense Department passengers during January and a part of February to replace airlift lost with the grounding of 63 Lockheed C-121G aircraft powered with the Curtiss-Wright R3350-91 engine due to engine inspections (AW Jan. 4, p. 27).**

▶ Continental Airlines last week began acceptance of Hilton Carte Blanche credit cards for the purchase of on-line transportation. Three U. S. carriers previously signed contracts with the Hilton Credit Corp. agreeing to accept the credit plan—Northeast Airlines, Pacific Air Lines and Western Air Lines (AW Oct. 12, p. 48).

▶ **Aeroflot plans to introduce nonstop Tu-104 flights between Moscow and Cairo this month. The Soviet carrier has been making the jet run in the past with a stop at Tirana, Albania.**

▶ National, Braniff and Delta airlines have charged Eastern Air Lines with attempting to sway community support in favor of the airline's route request in the Southern Transcontinental Case after the close of the hearing and prior to a Civil Aeronautics Board decision. The three carriers have asked CAB to investigate the charges, and National has submitted to the Board more than 20 newspaper clippings of speeches and luncheons conducted by Eastern in what National terms a "concerted, extended and organized campaign" as evidence that the airline is attempting to influence a final decision in the case by indirect pressure on the CAB.

▶ **Federal Aviation Agency has contracted with the University of California for a special course in accident prevention and investigation to be given to inspectors of the agency's Bureau of Flight Standards. Course will include 260 hr. of classroom work combined with field trips. FAA inspectors chosen to take the course will be enrolled in the university as special students and will receive 10 semester hours of academic credit.**



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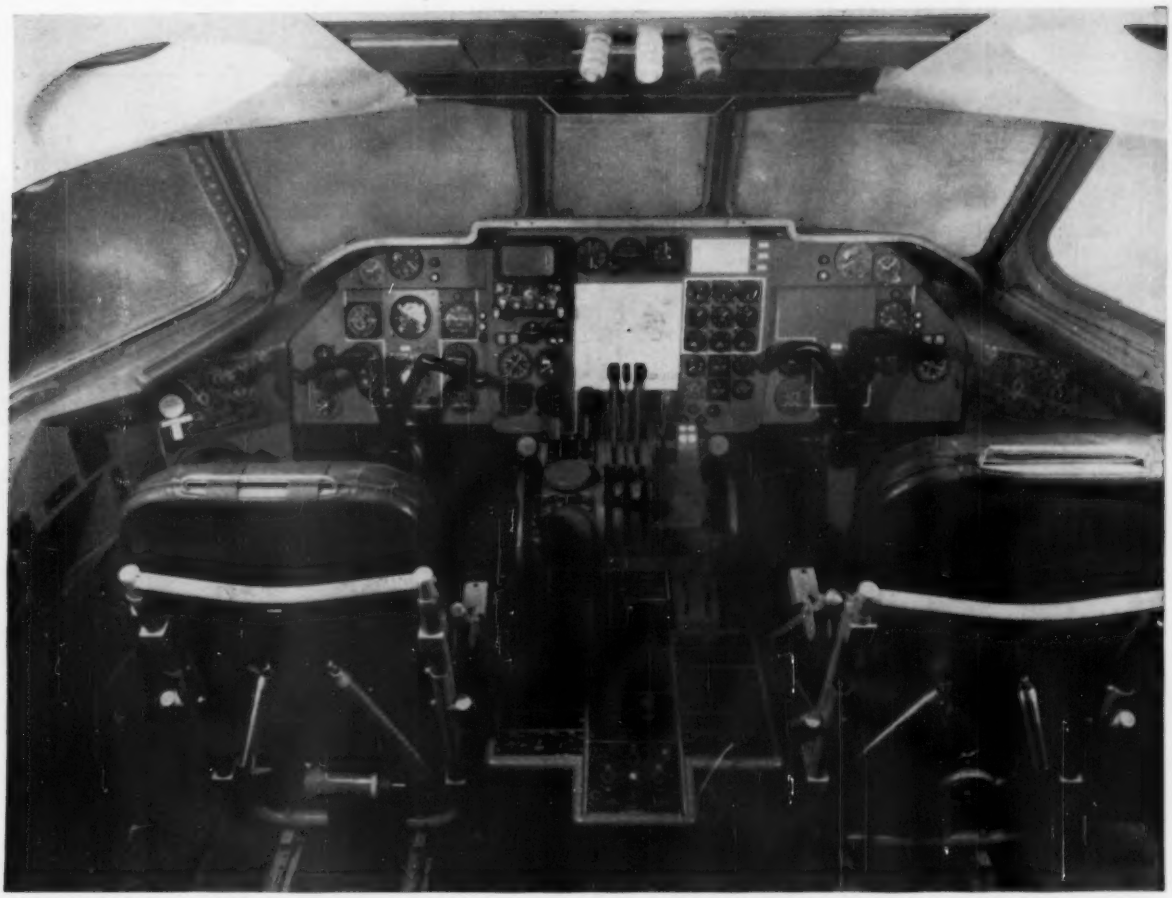
Airline Income & Expenses—November, 1959

(IN DOLLARS)

	Passenger Revenue	U. S. Mail	Express	Freight	Charter	Total Operating Revenue	Total Operating Expenses	Net Income Before Taxes
DOMESTIC TRUNK								
American	29,504,842	652,117	314,656	1,826,168	.....	32,705,771	32,335,073	370,698
Braniff	4,979,751	134,166	56,186	161,947	58,030	5,470,757	5,270,977	23,601
Capital	7,838,805	173,057	108,529	126,881	15,980	8,371,607	8,603,606	−231,999[2]
Continental	3,929,000	59,000	29,000	74,000	13,000	4,182,000	4,244,000	−324,000
Delta	8,052,000	156,000	85,000	318,000	.....	8,822,000	8,863,000	−175,000
Eastern	20,525,908	386,625	860,237[2]	.....	103,749	21,980,935	23,895,552	−2,268,920
National	4,868,013	101,658	28,894	160,970	70,311	5,346,900	6,362,713	−1,054,264
Northeast	2,048,644	38,136	17,146	45,813	.....	2,189,391	3,038,587	−849,196[2]
Northwest	5,536,684	202,023	539,209[2]	.....	15,195	6,333,414	6,601,150	−231,567
Trans World	19,612,974	569,280	1,134,826[2]	.....	226,206	21,702,349	21,890,343	65,265
United	18,554,017	655,077	1,640,599[2]	.....	299,145	21,468,830	24,330,793	−2,836,691
Western	4,751,068	110,005	35,000	89,170	22,318	5,074,006	4,361,047	619,088
INTERNATIONAL								
American	449,084	8,264	−266	36,360	.....	522,290	605,040	−82,750
Braniff	524,663	13,425	.....	38,977	.....	617,466	717,153	109,869
Caribbean Atlantic	217,835	2,363	10,787[2]	.....	768	233,556	223,086	10,181
Delta	258,000	4,000	.....	10,000	.....	284,000	418,000	141,000
Eastern	1,713,272	40,185	75,906[2]	.....	24,052	1,855,504	1,930,371	−103,784
Mackey	125,284	.....	225	2,882	.....	138,708	134,674	4,035[2]
National	140,483	3,895	2,383	11,467	.....	162,087	328,524	−166,437
Northwest	1,351,408	686,301	496,336[2]	.....	.....	2,810,560	3,018,020	−236,504
Pan American Combined	21,037,000	1,542,000	.....	3,185,000	552,000	27,248,000	28,351,000	−1,379,000
Alaska	216,000	16,000	.....	31,000	25,000	279,000	510,000	−231,000
Atlantic	9,454,000	698,000	.....	1,136,000	228,000	11,964,000	11,556,000	607,000
Latin America	5,501,000	196,000	.....	1,244,000	156,000	7,382,000	8,934,000	−1,570,000
Pacific	5,866,000	632,000	.....	774,000	143,000	7,623,000	7,351,000	274,000
Panagra	1,187,000	48,000	.....	191,000	3,000	1,574,000	1,643,000	−43,000
Resort	.....	.....	.....	.....	392,601[4]	393,784	388,114	5,670[2]
Trans Caribbean	257,562	.....	91,813[2]	.....	7,935	414,358	463,016	−61,037
Trans World	2,465,544	502,172	448,102[2]	.....	9,641	3,620,185	5,698,898	−2,152,403
United	668,197	39,841	24,438[2]	.....	6,600	749,032	816,175	−76,079
Western	331,602	4,462	.....	5,315	.....	349,382	356,859	−15,896
LOCAL SERVICE								
Allegheny	645,604	13,200	10,632	21,213	3,094[4]	893,560	1,018,937	−125,377[2]
Bonanza	315,376	3,122	1,311	4,165	5,143	522,298	575,831	−74,084
Central	167,623	7,579	2,912	6,042	5,409	419,377	440,707	−22,049
Frontier	448,565	12,194	4,125	25,297	13,682	881,323	1,094,615	−227,702
Lake Central	229,180	5,115	7,080	.....	2,649	393,345	383,104	10,241[2]
Mohawk	744,083	8,652	7,777	17,642	21,817	965,315	946,457	18,858[2]
North Central	906,877	25,051	13,500	15,499	23,635[4]	1,360,554	1,651,085	−307,968
Ozark	569,502	288,767[5]	8,064	17,651	1,860	893,130	932,847	−39,717[2]
Pacific[1]	.....	.....	.....	.....	.....	.....	.....	.....
Piedmont[6]	575,657	6,990	5,084	8,497	27,008[4]	874,647	991,071	−65,346
Southern	294,448	9,085	5,512	9,108	7,551	523,221	566,249	−43,027[2]
Trans-Texas[6]	373,600	12,658	5,692	15,820	11,201	663,558	659,905	2,799
West Coast	455,538	8,756	2,731	7,612	258	787,920	906,587	−118,667[2]
HAWAIIAN LINES								
Aloha	383,349	2,167	.....	5,328	457[4]	395,693	383,434	12,259[2]
Hawaiian	549,417	2,516	.....	65,840	105,495[4]	746,011	684,551	42,055
CARGO LINES								
AAXICO	.....	.....	.....	.....	842,532	969,564	771,443	198,121
Aerovias Sud Americana	.....	.....	.....	148,304[8]	.....	233,362	238,263	4,901[2]
Flying Tiger	.....	26,519	1,222,730[2]	.....	476,351	1,734,703	1,917,178	−239,498
Riddle	.....	.....	.....	442,165	.....	448,808	534,476	−85,668[2]
Seaboard & Western	.....	.....	.....	.....	.....	1,628,715	2,070,944	−415,768[2]
Slick	.....	.....	.....	.....	1,067,931	1,132,335	1,007,687	125,039[2]
HELICOPTER LINES								
Chicago Helicopter	119,970	146,854[5]	.....	.....	.....	267,128	231,510	33,192
Los Angeles Airways	15,625	11,631	7,884	.....	.....	111,489	109,573	2,027
New York Airways	75,158	3,672	1,290	3,580	.....	268,400	292,073	−25,501
ALASKA LINES								
Alaska Airlines	160,565	56,917	959	36,542	167,405	701,125	684,625	5,511
Alaska Coastal	64,985	7,768	.....	6,930	1,962	152,749	157,778	−2,383[2]
Cordova	12,272	7,658	.....	5,469	22,172	98,587	98,587	−2,073
Ellis	42,900	5,700	5,100[2]	.....	400	98,600	85,500	13,100[2]
Northern Consolidated	61,053	42,042	.....	25,092	8,948[4]	185,554	211,452	−25,899[2]
Pacific Northern	354,817	61,276	2,112	65,444	.....	726,202	826,502	−111,977
Reeve Aleutian	90,663	41,708	.....	28,884[7]	23,086	176,644	133,885	41,897
Wien Alaska	58,580	45,819	.....	23,548	15,268	271,284	328,527	−57,244[2]

[1] Not available. [2] Property figure [3] Net operating income [4] Non-scheduled transportation [5] Includes federal subsidy
[6] Airline division figures [7] Freight & excess baggage [8] Common carriage
Compiled by Aviation Week from airline reports to the Civil Aeronautics Board.



MOCKUP of de Havilland DH-121 jet transport cockpit shows roominess available to pilots. Note pictorial navigation display just above the throttle pedestal. All warning signals are centrally displayed under the right center window column.

De Havilland Plans DH-121 Fuel Increase

By John Tunstall

London—De Havilland Aircraft will build a 7,000-lb. stretch into the DH-121 short haul jet transport to enable operators to utilize the fuel tankage potential of the wing center torsion box. The fuel capacity of this section is surplus to requirements over the ranges for which the aircraft has been "uncompromisingly optimized."

Grossing 112,000 lb. with the new tankage, the triple-jet aircraft now can carry its full designed payload of 20,000 lb. without a cost penalty over distances of 1,400-1,500 stat. mi. as against the optimized range of 800-1,000 stat. mi. Full load range of the aircraft consequently now compares with projected medium range jets.

The only concession, according to de Havilland, apart from some minor structural reinforcement, is an increase in takeoff distance from 6,000 ft. to 6,700 ft.

The DH-121 has been optimized to operate over stage lengths of 800-1,000 stat. mi. using three cruise procedures and giving seat mile costs as low as 1.04 cents for the 100 economy seat configuration (AW Aug. 31, p. 40).

Projected Speeds

Its direct operating cost figures and economical cruising speeds, Mach 0.870 (585 mph.) at 32,000 ft. and maximum cruise speed of Mach 0.875 (606 mph.) at 25,000 ft., are claimed by the company to be superior to any commercial jet flying or planned.

For short haul operations, fuel for the DH-121 is contained in two inboard tanks, one feeding each of the outer engines and in two outer tanks each combining to supply the center engine. Capacity of the four tanks is 4,610 U.S. gal. As the wing runs continuously, fully skinned, from wing tip to wing tip, the wing center section under the fuselage provides integral tankage for approximately 1,200 U. S. gal.

First flight of the DH-121 now is scheduled for December, 1961. The company plans to build seven development aircraft during the following year and to obtain United Kingdom-U.S. certification within 18 months of the first flight. Production target is six aircraft per month and deliveries to new customers are expected to begin toward mid-1963. The aircraft is being offered with spares at around $3 million.

Wing Details

New wing details revealed by de Havilland show a twisted wing with negative camber at the tip (4 deg. at the root, minus 1 deg. at the tip). The company has chosen a relatively low cruising lift coefficient with which it is easier to predict reliable drag figures.

In spite of the rear engine configuration, a full movement of the center of gravity of 0.3 mean chord can be accepted which is not load limiting. Powerplants are Rolls-Royce R.B. 163 bypass engines of 10,100 lb. thrust each.

Tests will be made to confirm the

feasibility with this engine arrangement of using reversed thrust on the outer engines to achieve high descent rates in icing conditions. The landing gear has also been stressed to act as a drag brake in the same conditions.

Multiple redundancy is the principal safety feature of the triplicated systems built into the design to meet the blind landing requirements. A duplex autopilot has been developed in which one channel output is continuously compared with the other and both automatically cut out if any disagreement develops.

Automatic Landing

It is intended that automatic flareout will be introduced when the aircraft enters service but when this will lead to a reduction of weather minimums is uncertain. Adoption of full automatic landing system is not anticipated much before 1970 due to unacceptable azimuth tolerance of some ILS equipment.

Nevertheless, the equipment makers feel that totally acceptable ILS installations could easily be readied for the service date of the DH-121, if the requirements were firmed.

Notable features of the DH-121 cockpit include a pictorial navigation display above the throttle pedestal and a centralized presentation of all warning signals, placed under the right center window column.

Pictorial navigation display is favored by de Havilland but no definite assurance that such a system will be available has been offered by equipment makers.

Radio Altimeters

Triple automatic flareout radio altimeters are displayed above the flight instrument panels of each pilot and alongside the radio magnetic indicator which is on right of the captain's flight instrument panel and below the weather radar.

Below this latter group are the doppler and Tacan indicators.

Grouped on the forward pedestal are the parking brakes, speed brakes and spoilers, throttles and landing gear levers. Aft of the brake lever are the rudder and aileron trims with tail trimmers on either side of the pedestal. In the center of the pedestal are the fuel cocks and aft right are the flap and leading edge controls. Forward of the radio controls at the rear of the pedestal are the autopilot controls.

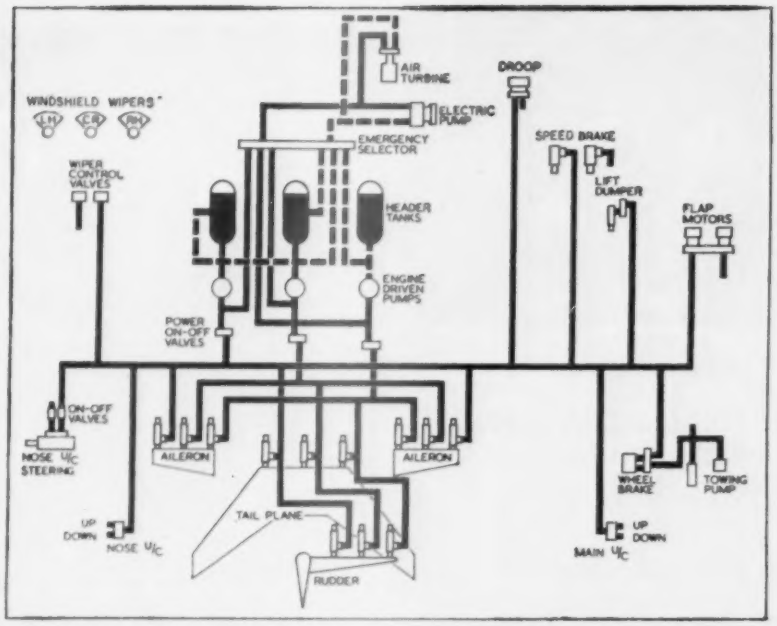
Engine, landing gear nose and main flap and brake indicators are on left of the copilot's panel. Radio and switch panels and hydraulic selectors are located on the ceiling. Duplicate nose steering wheels are placed at the captain's and copilot's outboard panel.

The company says the three-engine arrangement gives a cost advantage of between 2-3% over a four-engine model below 1,300 mi. stages.

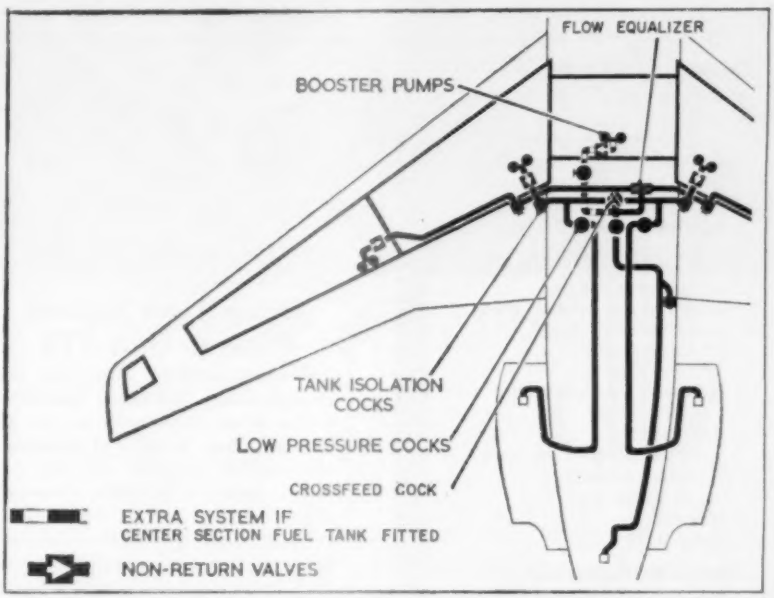
Based on a range of 800 mi., the takeoff thrust requirement for a three engine configuration is the same as the maximum cruising thrust. But a twin-engine aircraft is overpowered on the cruise by as much as 25% while a four engine aircraft is overpowered on takeoff by 20%.

De Havilland has said the DH-121's sales expectations are a minimum of 300 airplanes. The company thinks the plane has a sales potential in the U.S. and in South America and plans to survey these markets.

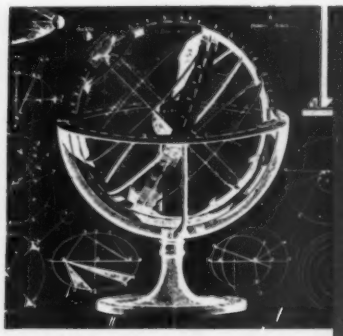
In particular, the DH-121 is aimed at regional operators in Western Europe, the Middle East, Southeast Asia and in Australia. Market estimates are based on replacement of existing Vickers Viscounts and Convairliners.



CIRCUITS in the DH-121 hydraulic system are powered by the three engines. System functions with two circuits switched out. An electric pump replaces any engine pump and an air turbine can energize all three hydraulic circuits.



DH-121 triple-engine arrangement allows for a comparatively simple fuel system. Port inner tank feeds the port engine; starboard inner tank feeds the starboard engine and two smaller outer tanks combine to supply the center engine. Center has 1,200 gal. capacity.



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Faster Service, New Equipment Planned by Aeroflot for 1960

Moscow—Planning by Aeroflot, the Soviet airline, for 1960 includes faster service with new and better equipment, the beginning of a large new airport construction program and establishment of regular helicopter service.

In an interview published in Sovetskaya Rossiya, Aeroflot chief Y. F. Loginov said jets and turboprops will replace piston-engine aircraft on routes connecting Moscow with Murmansk, Riga, Minsk, Kishinev, Simferopol, Krasnodar, Mineralniye-Vody, Siktivkar, Norilsk, Kuibyshev and Yakutsk.

As an example of faster service, Sovetskaya Aviatsiya, official publication of the Russian air force, recently reported that the Il-18 turboprop transport can make the round trip from Moscow to Yakutsk, with an intermediate stop at Krasnoyarsk, in 18 hr. flying time, plus 2½ hr. turnaround time at Yakutsk. This was described as approximately three times faster than service with piston-engine aircraft. Turboprops also will displace piston aircraft on routes from Moscow to Vienna, Berlin, Stockholm and Helsinki.

Additional planes will be used on routes from Moscow to Peking, New Delhi and Copenhagen. The Tu-114 turboprop transport will be pressed into service in the second quarter carrying up to 200 passengers on nonstop flights from Moscow to Vladivostok or Petropavlovsk-Kamchatsky, according to a statement by Aeroflot officials in Trud.

Piston-engine Il-2, Il-12 and Il-14s have been transferred to serve the provinces.

Loginov also disclosed that a regular Arctic airway will be opened within the next few months. Connected to the existing trans-Siberian route by air corridors, it is expected to improve service by offering an alternate in bad weather.

At Moscow's Vnukovo Airport, construction is scheduled to begin within the near future on a new terminal with a capacity of 2,000 passengers. A new terminal also is scheduled for Moscow's Sheremetyevo Airport. Under consideration is a plan for the construction of a futuristic international airport near Moscow with special docks at which passengers will unload.

Loginov said construction will begin in Moscow this year of an air service building at which passengers can obtain flight information, buy tickets and "register one's luggage and not have to worry about it any more."

Passengers will be flown by helicopter from the center of Moscow to Vnukovo, Sheremetyevo and Bykovo airports. And by the end of this year, helicopters are scheduled to service more than 100 routes totaling 6,214 mi. in the Russian Federation alone. Regular helicopter service also is being opened in many districts of the Caucasus, Middle Asia, Siberia and Far East.

In the Far East, Loginov pointed out, "to travel few tens of kilometers in the wild Taiga, local inhabitants have to spend days and even weeks. A helicopter will fly the distance in a few minutes or hours."

G. A. Piskov, one of Loginov's deputies, reported in a Trud article that Aeroflot carried 50% more passengers last year than the year before. He said this year "we are planning to carry twice as many passengers as last year on jet planes alone."

Flying Tiger Strike Off

Threatened strike against Flying Tiger Line by the Air Line Pilots Assn. set for last week was postponed indefinitely by the pilots' union. According to a Flying Tiger spokesman, ALPA issued a statement saying that it bowed to the requests of the Federal Mediation Board in diverting the proposed strike although Flying Tiger said it had no prior knowledge that the FMB was involved.

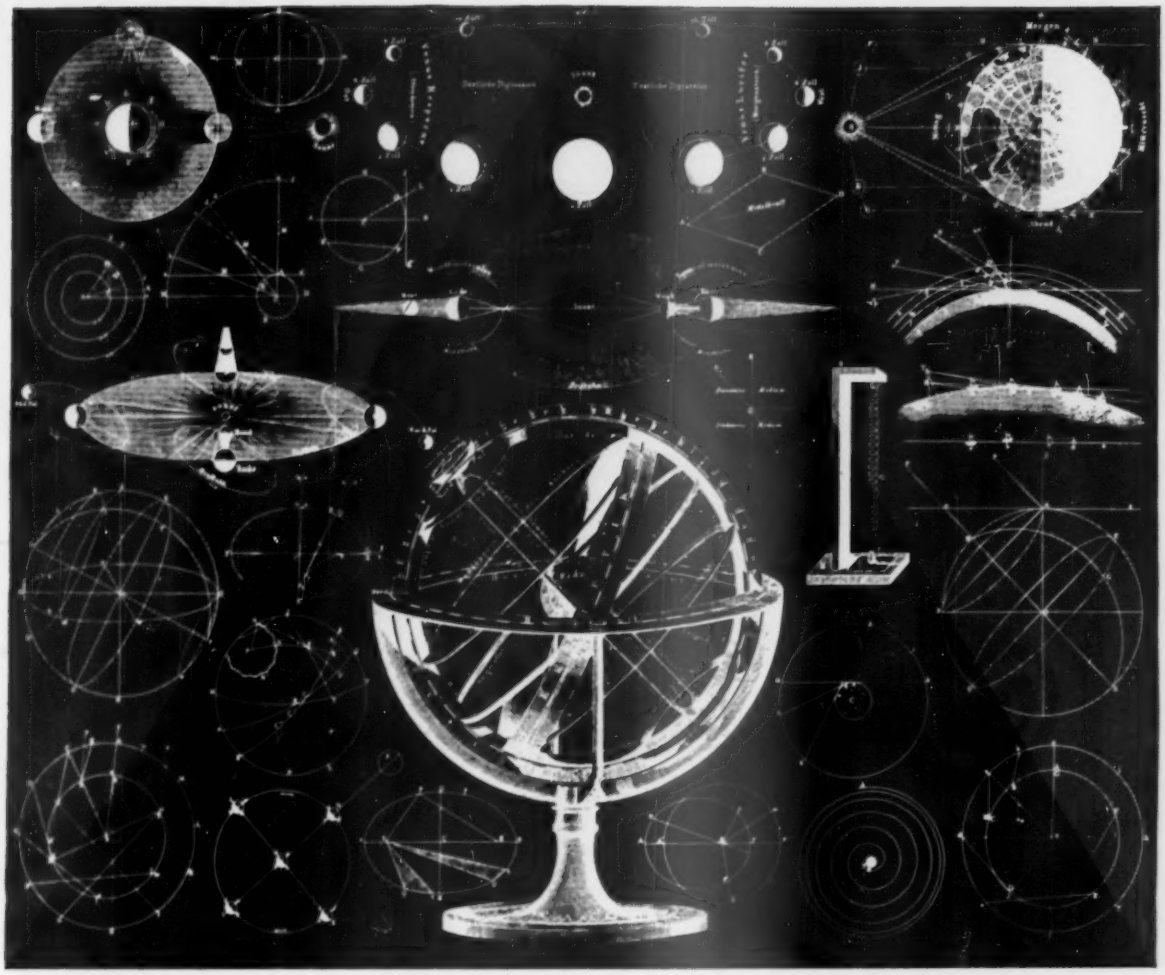
Flying Tiger Reports Plans to Quit ATA

Washington—Flying Tiger Line, the all-cargo carrier, has begun procedures leading to its resignation from the Air Transport Assn. because of dissatisfaction over ATA policy and pro rata charges made for the airline's membership.

Flying Tiger spokesmen point out, however, that the resignation, under ATA by-laws, will not become effective for six months and that further discussion could result in the airline remaining in the association.

Major reason behind the resignation, the airline said, is that Flying Tiger feels ATA concentrates too heavily on the promotion of airline passenger travel and fails to devote enough effort to solving the problems of the airfreight industry.

The carrier said it also feels that, since ATA does concentrate primarily upon airline passenger travel, its pro rata membership expenses should be considerably lower than they are.



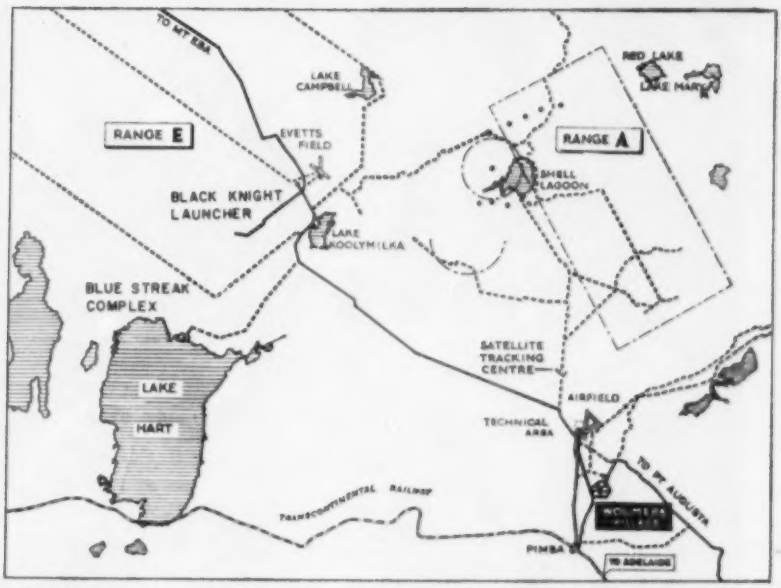
Guided tour of the solar system

The new NASA Thor-boosted research rocket, DELTA, now being constructed by Douglas, will set up big signposts for further space explorations. Combining elements already proved in space projects with an advanced radio-inertial guidance system developed by the Bell Telephone Laboratories of Western Electric Company, DELTA will have the versatility and accuracy for a wide variety of satellite, lunar and solar missions. Douglas insistence on reliability will be riding with these 90 foot, three-stage rockets on every shoot. At Douglas we are seeking qualified engineers to join us on this and other equally stimulating projects. Some of our requirements are listed in our column on the facing page.

Maxwell Hunter, Asst. Chief Engineer—Space Systems, goes over a proposed lunar trajectory with Arthur E. Raymond, Senior Engineering Vice President of DOUGLAS

MISSILE AND SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ DC-8 JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND SUPPORT EQUIPMENT

BLUE STREAK will be tested at Woomera, where a complex for the vehicle is under construction. Test stand above is at Hatfield, England.



MAP shows Woomera launching areas. Village is 26 mi. from Koolymilka area. Blue Streak complex is being built now on north shore of Lake Hart, a dry salt pan.

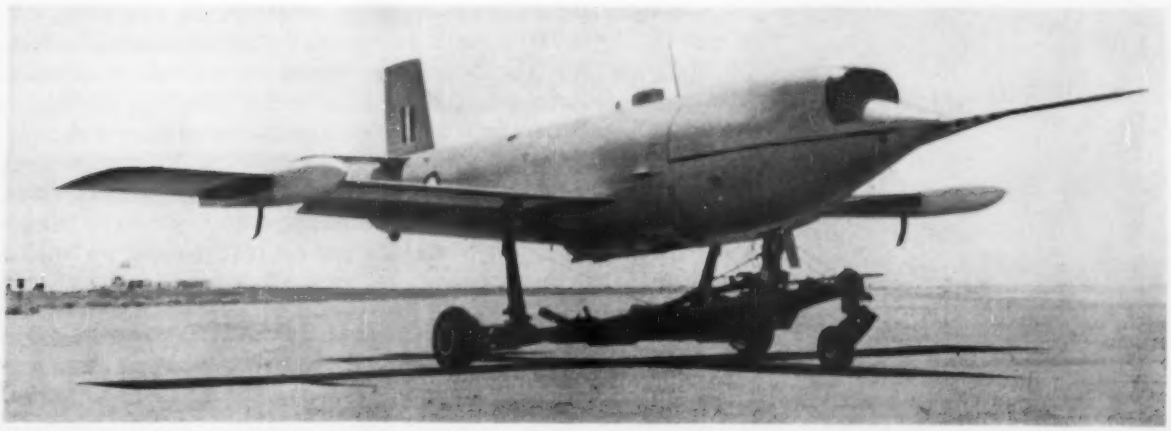
Woomera Range Prepares

Adelaide, Australia—Woomera Rocket Range, inaugurated 10 years ago as a place to test rocket defense weapons of nominal thrust, is now preparing to launch the Atlas-sized Blue Streak intermediate range ballistic missile sometime this spring. Blue Streak represents Great Britain's main hope of becoming a missile-space power in its own right (AW July 27, p. 32).

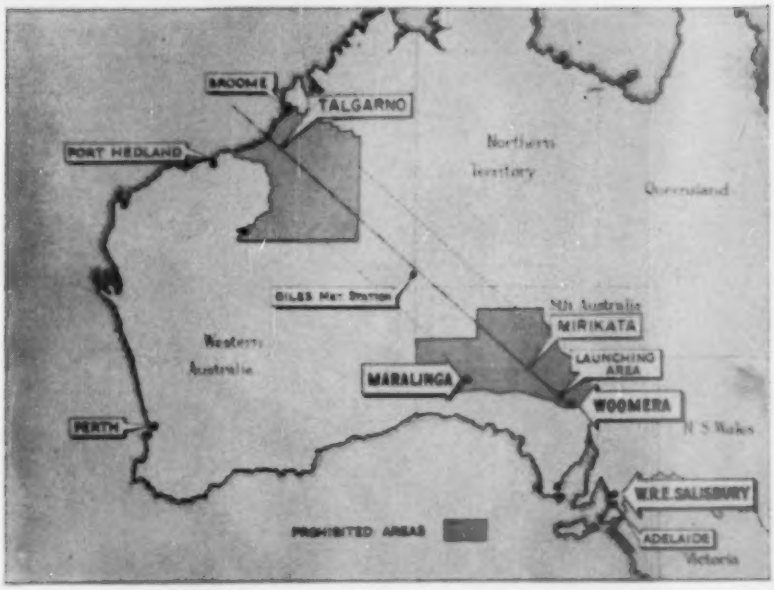
Starting with the simple steel guide rail system to launch such test vehicles as the Fairey VTO in 1949, sophisticated installations have been constructed under some of the most difficult heat conditions in the world in an area where isolation produces the problems of long-distance hauling of equipment and sparse communications.

Woomera now encompasses five basic pads, some of them with half a dozen launchers installed. They are:

- **Skylark and similar** upper atmosphere research rockets, including Long Tom, Aeolus and others put together on site from virtually off-the-shelf components.
- **Pads Two and Three,** catering to such ground-to-air missiles as Bloodhounds and Thunderbirds and their more sophisticated successors.
- **Black Knight area,** from which five missiles have been fired thus far without hitch to altitudes of up to 450 mi.
- **Blue Streak complex** under construc-



JINDIVIK IIA developed and built in Australia and powered by Armstrong-Siddeley Viper, serves as missile target drone.



MAJOR intermediate tracking station will be built at Mirikata about 120 mi. from range head. New tracking "town" is being built at Talgarno, some 1,000 mi. uprange.

for Blue Streak Launch

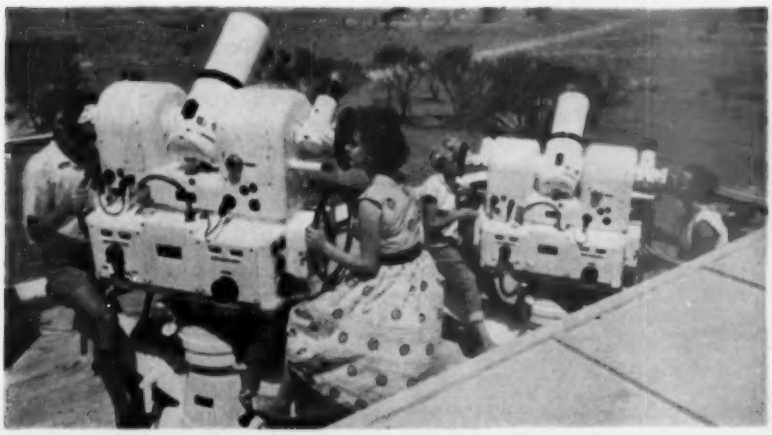
tion at Lake Hart (see map) where 150-ft.-high cliffs and gullies have been taken advantage of in the design of flame flues and exhaust outlets. De Havilland is responsible for the Blue Streak missile, with Rolls-Royce providing rocket engines and Sperry providing the guidance system.

Distance between some of these pads is in miles, since space—which in this country is unlimited—has been traded for the reinforced steel and concrete blockhouses which typify safety measures at Cape Canaveral in the U. S.

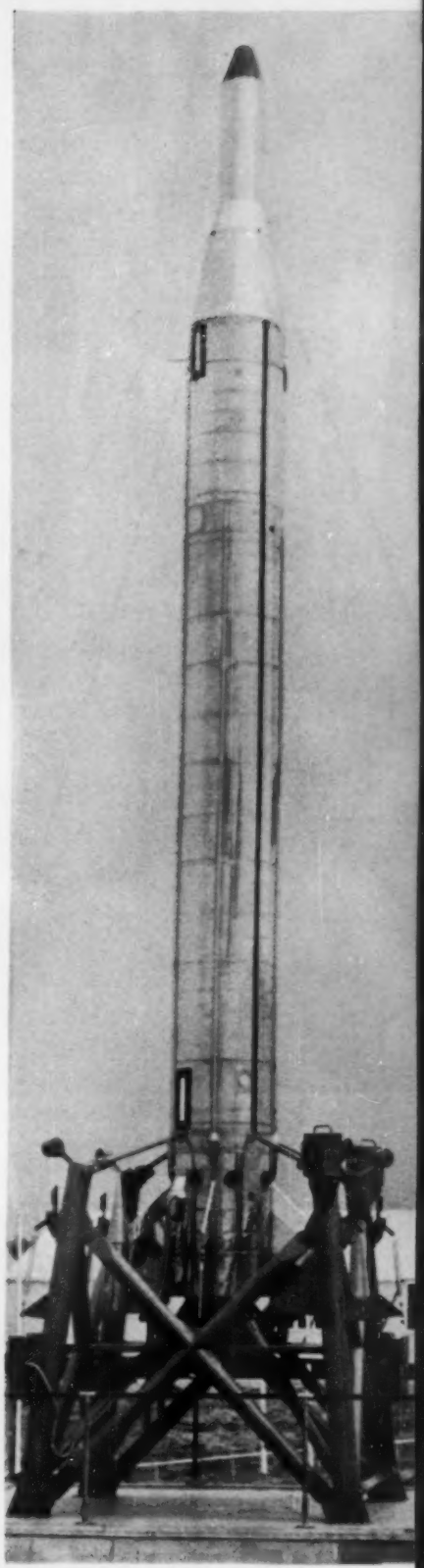
This means that the minimum number of protected buildings have had to be installed, yet work can proceed in safety on one pad while explosives are being handled on its neighbor.

Roughly 10 mi. separate one end of the line of pads from the other, but there is no reason or intention to fill in the front with closely spaced complexes as at Canaveral. The line roughly faces the northwest, with the main instrumentation building to the rear. The highest spending program ever at Woomera is currently in progress, with the firing of Blue Streak imminent. From a level of around $15.7 to $22.4 million a year for the past few years, this year's spending has risen in excess of $33 million.

This amount pays the wages of

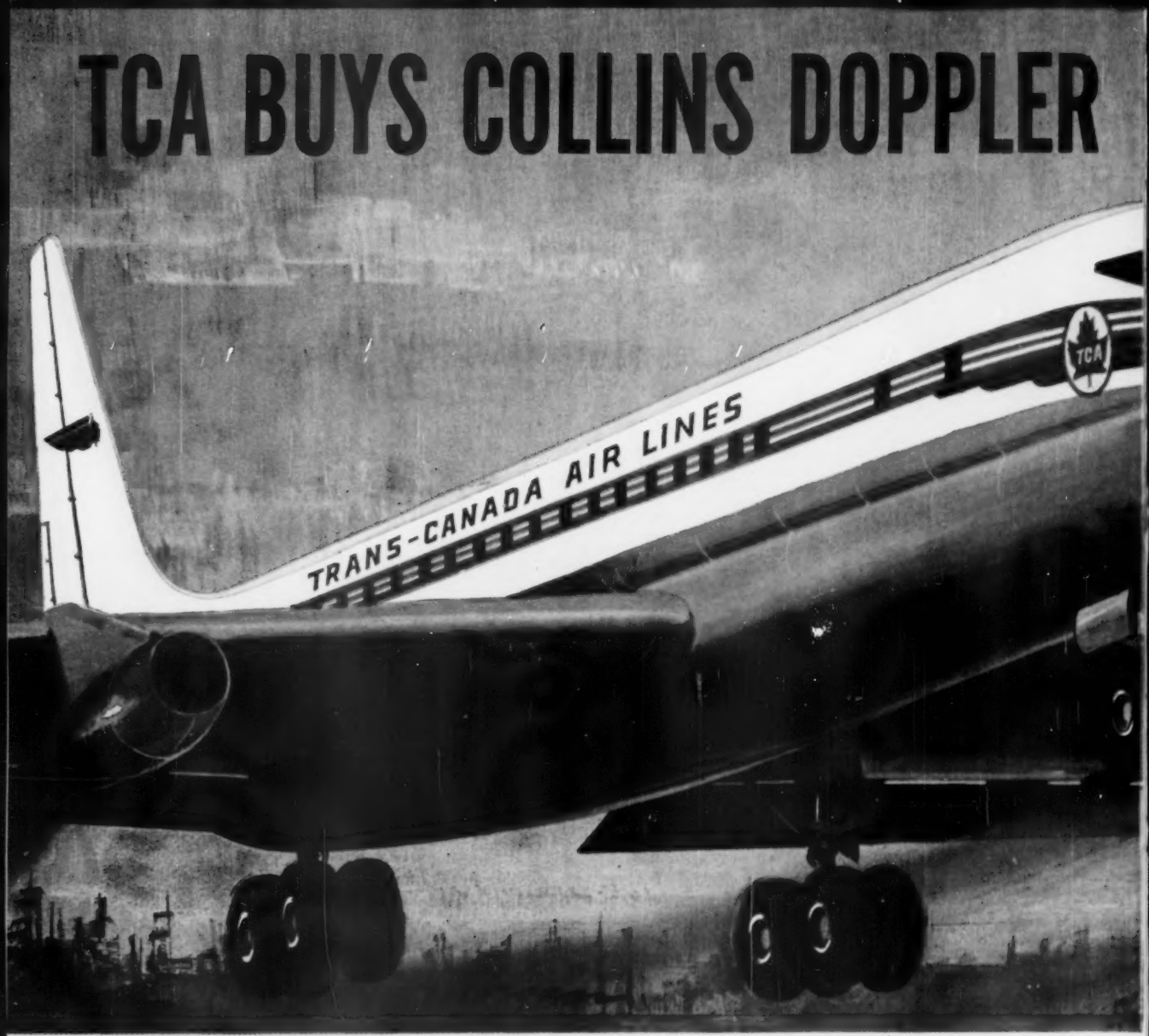


CONTRAVES Kinetheodolites for optical tracking are replacing older Askania models.



FIVE Black Knight vehicles have been fired from Woomera to altitudes up to 450 mi. Two-stage version is shown.

TCA BUYS COLLINS DOPPLER



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Lightweight, transistorized design of 11 tubes and 41 transistors provides extended reliability through simplified circuitry. Sensor weighs 58 lbs.; dual

FOR DC-8 JETLINERS

system, 99 lbs., with navigation computor, 20 lbs. The entire system can be fully checked on the ground without expensive flight testing.

Automatic acquisition and tracking is accomplished through staggered-tuned discriminators. This eliminates manual slewing, reduces pilot operating time. Self-calibration of the trackers prevents aging errors. Maximum error: Drift angle — 0.5°, computed, 1° indicated. Ground speed — 1 knot +.6%, computed, 3 knots +.6% indicated. Navigation Computer accuracy exceeds ARINC specification of .5% of total distance traveled for both along track and cross track indications.

For further information and technical specifications write to Collins Radio Company, Aviation Sales, Cedar Rapids, Iowa.

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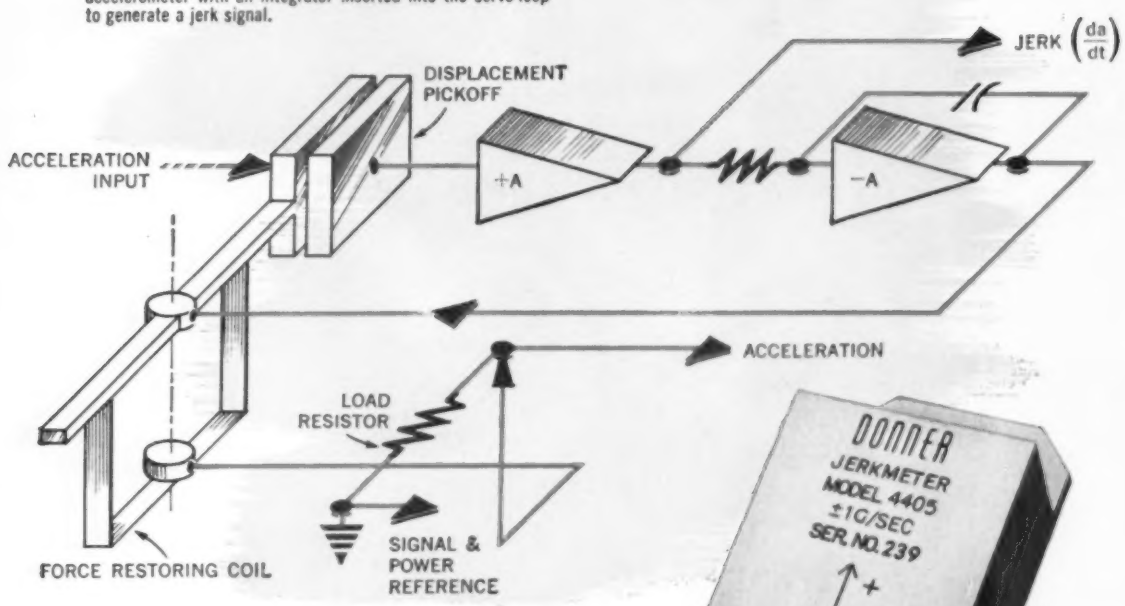
● Functional diagram of Donner Linear Jerkmeter. This unique instrument operates as a subminiature servo-system of the force-balance type which is responsive to jerk along the sensitivity axis of the linear unit and about the sensitive axis of the angular unit. Basically, the system consists of a transistorized accelerometer with an integrator inserted into the servo-loop to generate a jerk signal.



HOW TO MEASURE $\frac{da}{dt}$

Full size view of Donner Model 4405 Linear Jerkmeter

New Donner precision Jerkmeters measure linear and angular jerk to ±0.5% or better.

If your measurement and control problem requires accurate measurement of jerk or the rate of change of acceleration, Donner Scientific's new line of precision angular and linear jerkmeters can help.

These new instruments are the only truly accurate device of this type ever made. They are designed to meet the most demanding applications. Both angular and linear jerkmeters provide an output voltage proportional to jerk which in turn can be used to instigate compensatory control forces or other actions. *An acceleration analog output voltage is also available.*

Typically, a jerkmeter installed in a jet aircraft will provide an instantaneous output proportional to the rate of change of g's. This signal can be used to predict impending disaster conditions.

Other applications include use wherever constant acceleration is required. Here, the Donner jerkmeter provides a "velocity-damping" term. The jerkmeter also provides a third order term for stabilizing displacement devices. It can also be used as an inertial indicator of first motion.

KEY SPECIFICATIONS for Model 4405 Linear Jerkmeter

RANGES
Acceleration: ±1 g full range to ±30 g full range
Jerk: ±0.5 g/sec full range to ±20 g/sec full range

OUTPUT FULL SCALE
Accelerometer: ±7.5 v dc
Jerk: ±7.5 v dc

RESOLUTION
0.1% full scale or better

LINEARITY
0.1% full scale or better

HYSTERESIS
Less than 0.1%

POWER
+15 v dc at 10 ma and −15v dc at 10 ma

SIZE
3" long, 1½" wide, 1⅝" high

WEIGHT
7.5 ounces

WANT MORE INFORMATION? *The new Donner Jerkmeter is another product from a firm specializing in the manufacture of accurate fixed and general purpose analog systems designed to analyze, measure, and control inputs interlocking time, acceleration, jerk, velocity, and other dynamic inputs. Complete technical information can be obtained by calling your nearby Donner engineering sales representative or writing Dept. 05-1.*

DONNER SCIENTIFIC COMPANY
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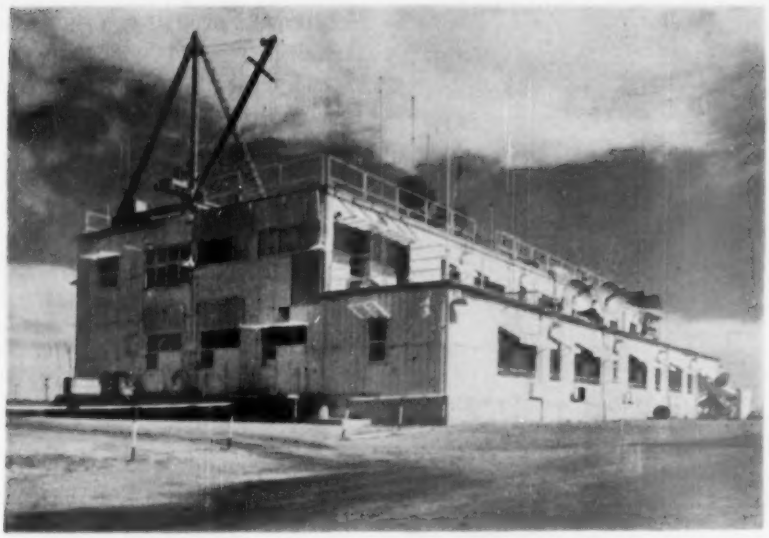

INSTRUMENTATION building in technical area is control center for all missile shots.

roughly 5,000 employes of the range project as well as financing capital installations. It has nothing to do, of course, with the cost of missile development from the contractors' end.

Most, if not all the additional spending is on the Blue Streak program. This covers the launching complex, additional downrange and flank recording and tracking stations, and a complete new town of permanent dwellings near the impact end of the flight line.

This is the town of Talgarno, 100 mi. inland from Broome on the northwest West Australian coast, where temperatures in shade soar regularly to 110-120 deg. in summer and have been as high as 137 deg.

When finished, it will be a fully equipped township with school, hospital and entertainment facilities which will outstrip any other town on the coast.

The impact area itself will be sufficiently far from the village to ensure safety. Safety is taken care of by an automatic self-destruct mechanism within the missile.

System Tested

This system, designed by Australian scientists, has already been successfully tested on the Black Knight, although it has not been necessary to destroy any of the five shots so far in flight.

Black Knight is, in respects, a cut-down test prototype of Blue Streak used for advance trials of controls systems, tracking and nose cone designs.

Firing angle in all cases has been to obtain height, and downrange impact has been as little as 50 mi. The Atlantic Missile Range's inner chain of islands, down as far as Mayaguez, would fit nearly between Woomera and Talgarno.

It is the intention of the British and Australian governments at some distant date to extend Woomera's overland stretch out to the Indian Ocean and Christmas Island, giving an over-all limit of something like 4,000 mi.

There is nothing positive about this as yet, however. Because of the nature of Woomera's tests of high flying ballistic missiles, there will be no need to install the expensive chain of stations which Canaveral required when its program was based on such low flying airbreathers as the U.S. Snark and Navaho.

Tracking Facilities

There is fairly concentrated close-in telemetry, optical and radar tracking at the launch end, and similar installations are going in at the re-entry end, but there will be only one major station in between, a base to be called Mirikata, roughly 120 mi. from the range head.

Blue Streak will pass directly overhead at altitudes up to 500 mi. high.

Two major stations are to be built on either flank of the launch area for optical and radar tracking. These four stations will follow the takeoff to a point beyond the earth's atmosphere. A number of AN/FPS-16 radar units will be included in these installations.

New range equipment includes construction of an air separation plant for the manufacture of liquid oxygen and nitrogen, and to cope with additional heavy traffic, roads are being strengthened and widened.

Strict security still surrounds Blue Streak's specifications and performance capabilities, but it is generally assumed to be somewhere between Thor and Atlas in capacity and roughly the same dimensions as Atlas—70 ft. long by 10 ft. in diameter. E. C. Cornford, Royal

INFRARED DETECTION

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To the eye of the aerial camera, mountain tops go by faster than flat ground, blurring the image on fixed-speed film.

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WOOMERA village houses government and contractor employes who work at range.

Aircraft Establishment head of the guided weapons section, recently discussed a missile with the capabilities which are generally attributed to Blue Streak.

Blue Streak Trajectory

If his figures can be taken as a guide, the missile's trajectory allows for a powered phase of 2.8 min., with the cutoff at a height of 60 naut. mi. The missile then coasts to its apogee height of 500 naut. mi. reached 13 min. after launch.

Velocity at cutoff is just under 18,000 ft./sec. Cornford's computations and graphs discussed a range of 2,500 naut. mi., where the extended range will allow only half that distance.

Ultimate use of Blue Streak is likely to be from hardened underground bases. Rocketdyne, with which Rolls-Royce has a working cooperation agreement, recently has been experimenting with hydrazine as a fuel, and this might well be a future switch from the present kerosene and liquid oxygen.

De Havilland's G. K. C. Pardoe has made a series of proposals with Blue Streak as the basic tool in a space research program in a two-or-three stage satellite launching rocket. De Havilland has the biggest work force of any of the 11 private contractors associated with work at the range.

Over-all Picture

In a lecture to Royal Aeronautical Society in London, R. W. M. Boswell, controller of the Weapons Research Establishment, which has responsibility for Woomera and the Salisbury laboratories, presented an over-all picture of the range. Woomera's over-all average of about 3,300 hr. of sunshine a year was ideal, he said, for optical and electronic instrumentation. Four basic measurements were required of a missile flight, and to achieve this, instruments sought data on:

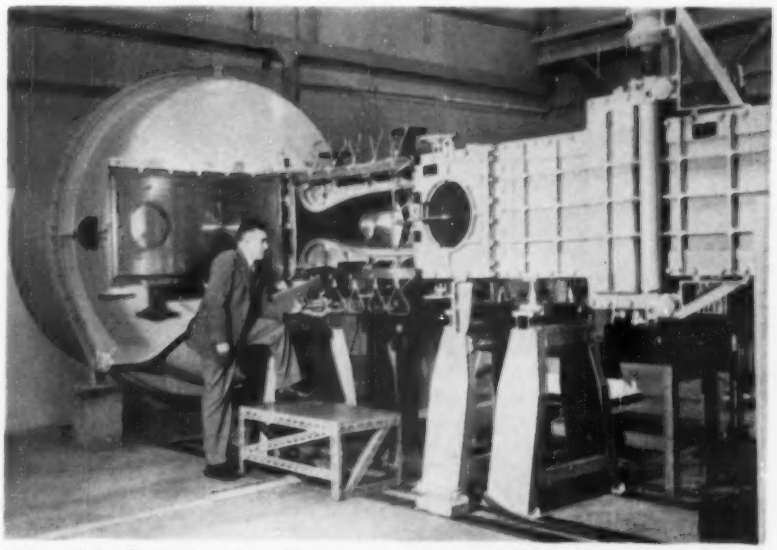
- **Internal behavior of a missile**—usually achieved by a telemetry system. Type in greatest use at the range was the SRDE/RAE frequency-modulated, time-multiplexed 24-channel system operating on a frequency of 465 mc. In recoverable vehicles, scratch or magnetic recorders could be used.
- **Position in space** of a missile to within a few feet of accuracy—from which information, velocities, miss distances and, in some cases, longitudinal accelerations, could be derived. Askania kinetheodolites have been replaced by the more accurate Contraves. Multistation doppler radar also is installed, but ease of computation makes optical methods preferable.
- **Position of ancillary flight** platforms to an accuracy of about 100 ft. such as targets, bombers and fighters requiring control over the range. Display in real time is a characteristic of this type of instrumentation. Both radar and a centimetric direction finding system are used to provide raw data from which results are displayed after computation in Cartesian coordinates on plotting tables.
- **External behavior** of the missile in flight—recorded by high-speed cameras. Present equipment includes a modified fire control radar aerial mount fitted with a Vinten HS-300 camera with interchangeable lenses up to 80 in. focal length.

Two other necessary facilities, of course, are suitable targets and a system to reduce data to information.

Flying Targets

Australian-developed and built Jindivik, near-sonic and capable of operating up to 50,000 ft., is the most widely used target. Venerable Meteors and Canberras fitted with remote control systems have been introduced recently and give longer range where required.

Jindivik is powered by an Armstrong-Siddeley Viper engine, has a fixed rudder, takes off from a ground trolley and lands on a small retractable skid. At least one or two Jindiviks have completed more than 30 missions. A new model, just coming into use, with a higher-powered ASV-11 engine, extended wingspan and other modifica-



TEST and development work at Woomera range is supported by laboratory facilities such as this supersonic wind tunnel at Weapons Research Establishment in Salisbury.

tions, has pushed ceiling up to 60,000 ft. and increased speed.

Data reduction is achieved with the Digital Weapons Research Establishment digital automatic computor (WREDAC), which accepts either paper or magnetic tape. Tabular display is by a rotary printer at a rate up to three lines each of 92 characters per second which is fast enough for present purposes.

Running in parallel with the tabulator are four Mufax printers (modified picture transmission units), each of which plots four of the 16 channels carrying missile data.

For kinetheodolite and other optical data not initially recorded on magnetic tape, semi-automatic film readers with punched paper tape output are used which may be fed into WREDAC in the same fashion as magnetic tapes.

Another basic difference between Woomera and Canaveral is that not only ground-to-air missiles are tested along with the coming ground-to-ground trials. Woomera also provides for air-to-air tests using North American Sabre-jet fighters and any one of the above mentioned targets.

Blue Steel Trials

Trials have also been conducted with the Avro Blue Steel stand-off bomb, using Vickers Valiant jet bombers. Further trials are to be carried out next year with Avro Vulcan jets.

Equipped with Baker-Nunn camera and Minitrack, the Woomera satellite tracking station is the only one outside the U.S. geared for simultaneous observations of orbiting satellites by radio and optical means. Linked directly with Washington by teleprinter, the station earlier this year photographed one of the Vanguard satellites at a distance of 2,500 mi. and Explorer VI at 14,500 mi.

The Minitrack radar unit, supplied by the U. S. Naval Research Laboratory, is housed in a 30 ft. trailer and uses eight aerials arranged in a 500 ft. square. It projects a fan-shaped beam covering 90 deg. north-south and 12 deg. east-west. Originally calibrated to work on 108 mc. frequency, hurried alterations had to be made before it was used to cope with the first Russian Sputnik's changed frequencies.

The Baker-Nunn camera was supplied by the Smithsonian Astrophysical Laboratory. Under optimum conditions, local operators claim they could photograph a tennis ball at 1,000 mi.

One other aspect of Woomera's future role has not been overlooked. This is the development of an anti-missile missile. By its very nature, Woomera is probably best suited of any of the big ranges for this work.

This development at the moment is believed to be based on current opera-

Yuba is constantly developing precision specialty components for integrated electronic systems in aircraft, missiles and industry. Yuba's proven capabilities for research, design, development and production assure you of the finest in precision equipment. In the field of airborne motors and generators, for example, Yuba-Dalmotor Division has moved ahead. They will design and produce to your strict specification—with minimum lead time. Shown above are several of the Yuba-Dalmotor's carefully produced precision products.

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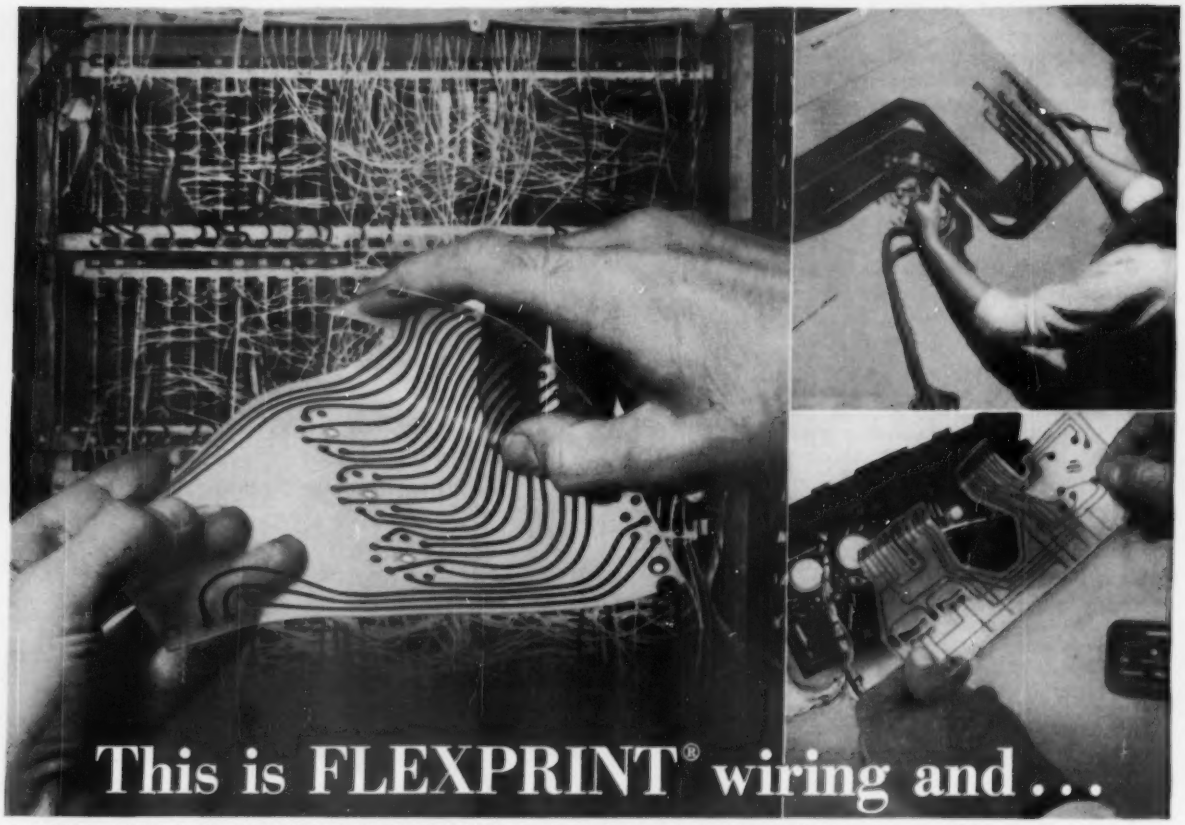

FLEXIBLE, FULLY INSULATED PRINTED CIRCUITS offer designers of electrical and electronic assemblies new opportunities to make rewarding contributions to quality-improvement, cost-reduction and miniaturization programs.

here's how to design more reliability per dollar per pound into less space!

Whether your design objective is to upgrade wired assemblies at the lowest total installed cost or to get the utmost reliability out of the least weight or space, FLEXPRINT® wiring offers definite advantages over any other design concept.

Quality Improvement

Reliability is inherent in the unique construction of FLEXPRINT wiring. It consists of etched patterns of flat conductors permanently bonded between and to sheets of thin, flexible plastic insulation. Only the terminations are exposed . . . and they can be encapsulated if necessary. *A closer look at each construction feature tells you why* FLEXPRINT wiring is more reliable than either conventional wiring or hardboard printed circuits. All conductors maintain their positions in relation to each other. All terminations are accurately positioned. No wiring errors! No disturbing cross-coupling effects, because they're known and constant. All conductors are encapsulated. No penetration of moisture and gases! Each circuit is flexible. No short or open circuits due to vibration and shock.

Cost Reduction

If cost-reduction is your goal, FLEXPRINT wiring wipes out any initial cost advantage of conventional wiring by economies all along the line. As a result, total savings in wiring costs as high as 50% can often be realized. Let's see why.

FLEXPRINT wiring comes ready for attachment. No selecting color-coded wires in assorted sizes, cutting them to length and lacing them in harnesses!

Every conductor and termination is in its right place. No wasted time and motion positioning them. Assembly time is minimum . . . as little as 1/5th the time required for conventional wiring. Available automatic assembly and soldering techniques save additional time.

There's only one way to connect a FLEXPRINT circuit. No wiring errors! Little or no trouble-shooting. Quality control and rework costs are substantially reduced.

Miniaturization

Substantial reductions in package size and weight also stem from the unique features of FLEXPRINT wiring.

Weight reductions of as much as 50% have been obtained by switching from conventional cables and harnesses to FLEXPRINT wiring of equivalent performance.

As a space saver, FLEXPRINT wiring has no equal. Savings in the size of

your equipment may run as high as 60%. That's because FLEXPRINT circuits can be twisted, folded, preformed and interwoven in single or multiple layers. *You make it conform to any housing geometry.* With it, you can make valuable contributions to miniaturization programs.

A Question And Answer Approach To The Use Of Flexprint Wiring

Making the transition to FLEXPRINT wiring poses no serious problems. Designers already working with hardboard printed circuits merely project their know-how into the third dimension to take advantage of flexibility and multi-plane construction. Others will find the basic knowledge and skill easy to acquire.

Fortunately, just about any question you could ask about FLEXPRINT wiring has already been asked by and answered for design engineers who are now successfully using it. Let's review a few:

Q. Does use of FLEXPRINT wiring represent radical departures from conventional wiring routines?

A. In most respects, use of FLEXPRINT wiring involves nothing new. Through breadboard and early prototype or model stages, procedures are identical. At that point, a sketch translates wires into flat, flexible cables or harnesses. Then, it's just a drafting job to refine the pattern and produce artwork for photography and etching. Remember, at any stage, you can call on Sanders for design assistance.

Q. Does FLEXPRINT wiring create any tough problems in terminations and connectors?

A. No! An exposed pierced pad, placed over a pin or wire and soldered with a 360° fillet, is the most common termination for FLEXPRINT wiring. Lap solder joints are also used. Termination strips, bare on both sides, are used for crimp-on connections. Many standard types of soldered and mechanical connections are available . . . and connector manufacturers are constantly creating new ones for FLEXPRINT applications. Usual considerations determine your choice of the right connector.

Q. What is the best way to solder FLEXPRINT wiring?

A. It depends on your particular application. Hand, dip, fountain and wave soldering may be used, as long as excessive heating of the thermoplastic insulation is avoided. Techniques employing the correct cleaning fluxes, timing and temperatures have been developed for various insulations.

Q. Can FLEXPRINT wiring be effectively shielded without depriving it of its flexibility?

A. Yes! External shielding is accomplished with adjacent layers of solid or latticed shields on one or both sides of conductors. Grounding adjacent conductors in the same layers produces internal shielding. Multi-layer techniques provide for twisted pairs and triplets.

Q. Can FLEXPRINT wiring be reinforced to add rigidity or meet environmental requirements?

A. Three methods are used to reinforce FLEXPRINT wiring: building up its insulation to add any degree of rigidity or thickness to any section; bonding glass cloth to its surface or molding it into its insulation; bonding FLEXPRINT wiring to such solid base materials as phenolic or epoxy glass . . . usually to replace combinations of printed hardboard and interconnecting wires with single pieces of FLEXPRINT wiring.

Q. Will lead time for delivery of FLEXPRINT wiring cause production delays?

A. No! Sanders production capacity is geared to match deliveries to your demands.

Q. How do I get started with FLEXPRINT wiring?

A. Your first step is to read the new bulletin, a "Designer's Digest," just off the press. It reviews several circuit design examples, shows other circuits now in use, lists new and tested applications and tells you just how to make the rewarding switch to modern flexible printed circuits.

For your copy, write:

FLEXPRINT®

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PRODUCTS DIVISION

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Leaders in Missiles / Space Technology —
BOOSTER SYSTEMS, ELECTRONICS, GROUND SUPPORT EQUIPMENT, AND NUCLEONICS.

MARTIN

tional anti-aircraft missiles like Bloodhound and Thunderbird and their more sophisticated successors, sharpened to a degree of accuracy and with their speed increased to a point where interception of a ballistic missile is possible.

Radar interception for early warning is required with this capability. Most likely site for the two required installations is in the Talgarno impact area.

Skydart I Target Evaluated by USAF

Reliability of 80%, based on actual flights, was reported for the Curtiss-Wright Corp. Skydart I aerial target (AW Dec. 14, p. 77) in a recent evaluation at Nellis AFB, Las Vagas, Nev. Tests were made with two of same type of aircraft, either a Lockheed F-104 or North American F-100, going aloft, one carrying the target with an infrared flare augmentation, while the companion aircraft carried and launched a Sidewinder missile.

Previous Skydart test was carried out at Holloman AFB last October and November, with the rocket-powered target achieving 90% reliability through 35 launches, at high speed and altitude. The target was designed as low cost, high performance unit which, while being expendable, could be launched at speeds from Mach 0.7 to 2.0 at altitudes from 30,000 ft. to 65,000 ft.

New Divisions Formed By Goodyear Aircraft

Goodyear Aircraft Corp. has reorganized its management approach and established three new divisions in order to consolidate operations and "implement the company's forward planning and development activity."

Goodyear also has established a product and program steering committee and a planning and development committee "to study and establish planning and policy for forward area programs not already falling within the province of the basic divisions." These divisions are:

• **Subroc Division,** managed by R. L. Burtner and responsible for the company's part in development of Navy's Subroc anti-submarine warfare missile program.

• **Avionics and Plastics Division,** managed by J. A. Keenan and responsible for plastics, the Mace missile program, operational flight trainers, process computers and electronics manufacture.

• **Aero-Mechanical Division,** managed by C. J. Pennig and responsible for lighter-than-air craft, miscellaneous metal work, Bondolite, rockets, ground handling equipment and radar.

★ *Positive Mechanically Locked Stem*
★ *Flush Fracture (No Stem Trimming)*
★ *Strong Clinch*
★ *Wide Grip Range*
★ *Positive Hole Fill*

The Cherrylock* "2000" Series Locked Stem Rivet offers every feature desired in an aircraft blind rivet . . . proven high sheet clamp-up with no stem trimming (fractures flush on installation), uniform head seating, complete hole-fill, wide grip range, and positive mechanically locked stem.

Fast, economical, easy installation (with no stem trimming) is available with Cherrylock rivets, using existing Cherry installation guns. You get better fastening at lower installed cost.

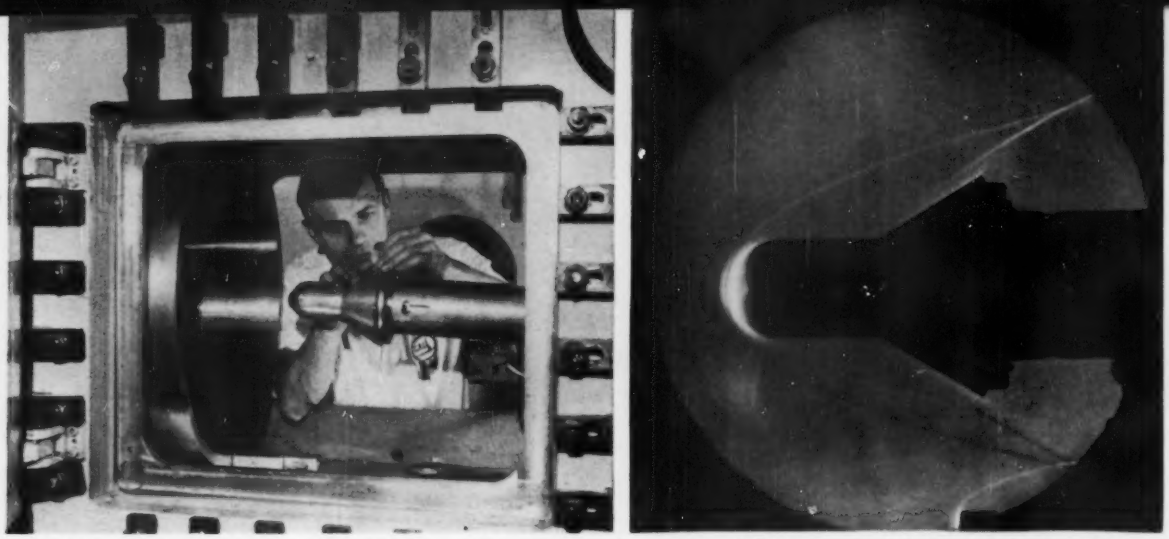
One rivet can be used for several material thicknesses, reducing stock requirements and lowering costs. Positive hole-fill, even in oversized holes, simplifies preparation problems to further reduce installation costs. Available in:

A-286 Stainless Steel—Monel—Aluminum

For technical data on the new Cherrylock "2000" Series rivets, write Townsend Company, Cherry Rivet Division, Box 2157-N, Santa Ana, California.

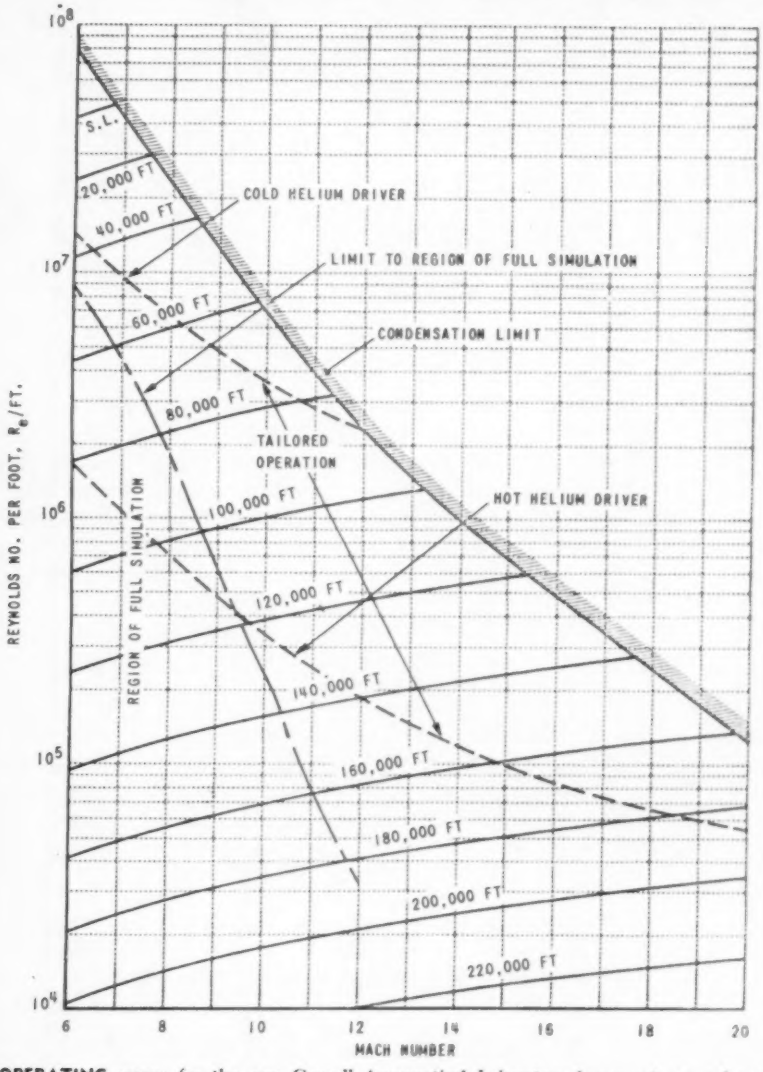
*Patent Pending

CHERRY RIVET DIVISION
Townsend Company



CORNELL hypersonic tunnel designed for highly accurate flows is shown above with model being mounted (left) and under test (right).

New Tunnel Design Improves Data Quality



OPERATING ranges for the new Cornell Aeronautical Laboratory hypersonic tunnel are shown above, with the region of full flight simulation in the lower left portion of the graph.

Buffalo, N. Y.—Significant improvement in the quality of hypersonic shock tunnel test data has been reported from the new 24 in. hypersonic tunnel at Cornell Aeronautical Laboratory as the result of a design effort to obtain more accurate and repeatable test conditions in pure air rather than extending the wind tunnel state-of-the-art into very high temperature and Mach number regions.

Critical Mach number (M) parameter in the Mach 6-20 Cornell Tunnel can be held within 0.05 M when operating around Mach 8 and to approximately 0.1 M at Mach 12 and above. Just a few years ago, data was considered good if test section conditions above Mach 8 were known within a whole Mach number.

Uncertainties this introduced into the model data are illustrated by the fact that at Mach 8, a 0.4 error in M would cause about a 20% error in dynamic pressure. At Mach 18, it takes a 0.9 error in Mach number to cause the same percentage error in dynamic pressure because a lower pressure operating gas is required. Model force coefficients depend directly on the accuracy of the dynamic pressure measurement and consequently would have a 20% error if the Mach number was off by these magnitudes.

The new Cornell tunnel makes it possible for much more accurate comparisons to be made of very high speed vehicle configurations, and if one is selected for development, model breakdown studies are possible to determine the effect of each main component on the over-all performance of the vehicle. The tunnel was first operated July 1, and a 100 hr. configuration investigation has been completed for the Air Force Wright Air Development Division, in addition to the lengthy calibration operation. Tests for General Ap-

plied Science Laboratories and Eastman Kodak Co. are now scheduled into the tunnel.

Basically, the 24 in. tunnel is the same type as the 11 in. tailored interface shock tunnel Cornell has been operating for over two years. The main advantage of such tunnels is that they have much longer testing times than conventional shock tunnels. Time during which the test conditions are steady in the 24 in. tunnel range from 20 to 5 milliseconds, depending on the test Mach number.

Normally, shock tubes 200 to 300 ft. long are required to obtain testing times which are only a small fraction of those available in the Cornell tunnels. On the usual shock tunnels, the shock has to make a long run down the tube so that a large pocket of high temperature air can be built up behind it.

In the Cornell tunnels, the shock wave is reflected off the nozzle and back up the tube so that it heats a longer pocket of air. Operation of this type of tunnel generally requires that the reflected shock pass through the interface between the driver and driven gas without creating additional shock waves. This can be accomplished by controlling the initial conditions of the driver and driven gas so that the resistance of the two gases to the passage of a sound wave is the same.

A variation of this type of "interface" operation has been successfully used at Cornell. The pressure of the driven gas is increased by an order of magnitude, and it has been shown that the effects of the weak shocks created at the interface can be predicted accurately. This "equilibrium" operation has been effective in increasing the Mach number at which complete flight simulation can be achieved by at least 2.0. The curve on p. 64 shows the Mach number and Reynolds number at which complete simulation is possible.

The large pocket of air under controlled conditions which is collected at the end of the shock tube is expanded through a nozzle of very large area ratio into the test section where the model is located. The small throat section of this nozzle makes it possible for the strong initial shock wave passing down the tube to be perfectly reflected. At Mach numbers 6 and 8, the nozzles on the 24 in. Cornell tunnel are axisymmetric, but boundary layer growth at the higher Mach number is so great that a pair of two-dimensional nozzles must be used. The first expands the flow to its full width horizontally, and the second expands it to its full height in the vertical plane. A boundary layer bleed is located between the two nozzles, which are flexible and can be adjusted for any operating Mach number.

ARS 1961 Meeting Will Be Largest

New York—To keep stride with the fast growing field of space technology, the American Rocket Society has begun preparations for the largest meeting in its history.

It will be the Society's 1961 annual meeting which will be held in the New York Coliseum, Oct. 9-13. The Society has reserved the Coliseum's four floors, three of which will be assigned as exhibition space and one as meeting rooms, for this conclave to be called "Space Flight Report to the Nation."

The Society, which is now growing at the rate of 4,000-5,000 members a year, expects to have a total membership of between 22,000 and 25,000 people by October, 1961. As presently planned, according to one ARS official, approximately 300 scientific reports will be delivered in five simultaneous sessions at the 1961 annual meeting, and between 500 and 650 exhibitors are expected to display their wares and services. In attendance, reports and exhibitions, the ARS 1961 annual meeting is scheduled to be four to five times larger than any ARS meeting to date.

Society officials are currently making arrangements with the National Aeronautics and Space Administration and the Department of Defense for their respective displays and expect to approach the first of the potential non-government exhibitors in about three months.

Martin Reorganizes Baltimore Division

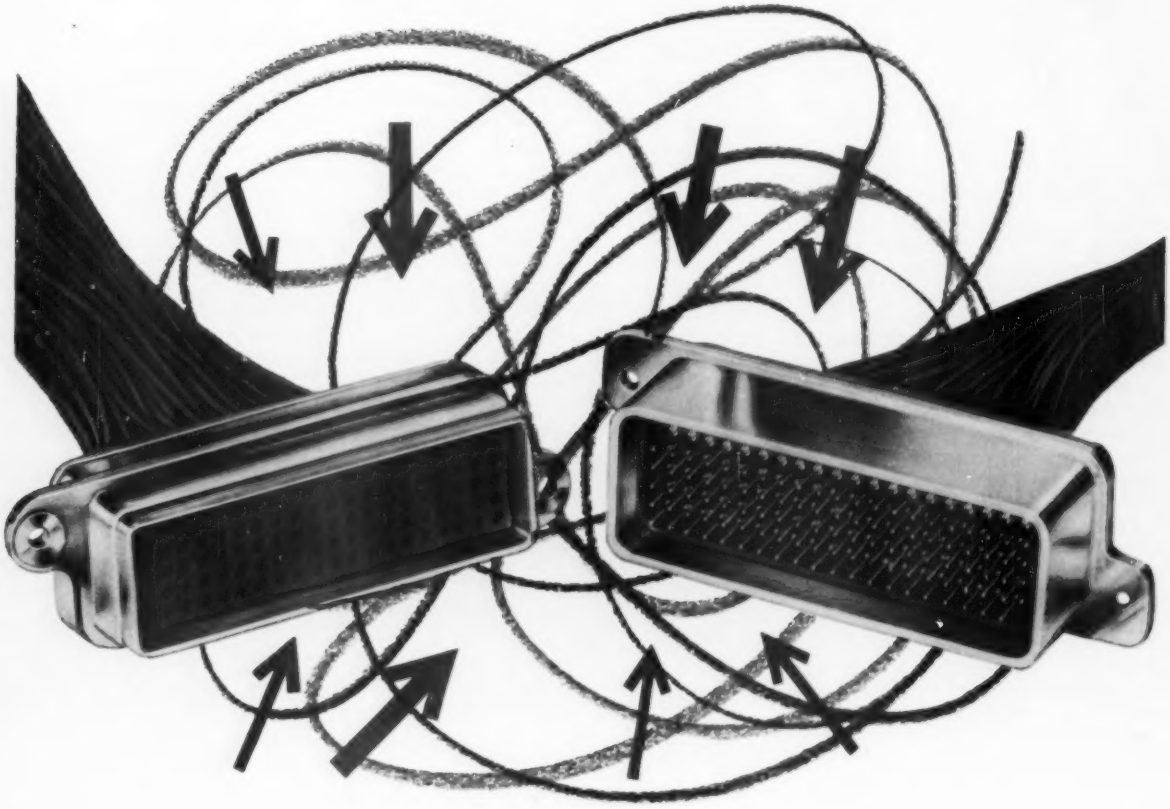
Baltimore, Md.—Martin Co. has reorganized its Baltimore Division to orient its capabilities to the missile, space and electronic fields as part of a major management realignment (AW Jan. 4, p. 18).

Heading the new Electronics Division is John J. Slattery, former manager of Magnavox Co.'s Government and Industry Division at Los Angeles, Calif. All Martin-Baltimore engineering, other than electronics, is incorporated in a new Weapons System Engineering Division headed by Herman Pusin. Fred R. Dent takes over the Mace program.

Bomarc Squadron Becomes Operational

Boeing Bomarc ground-to-air interceptor missile is poised on its launch pad at McGuire AFB, N. J., site of the first U. S. operational Bomarc unit, the 46th Air Defense Missile Sqdn. The squadron is responsible for air defense of a seven-state area.

WHEN THE DUTY'S ROUGH AND THE CIRCUITS ARE CRITICAL



***AMPin-cert* RACK AND PANEL CONNECTORS**—Here's a rack and panel connector that can really take a beating and keep right on going . . . performs like a champion in the toughest environments, with the roughest treatment yet gives enduring critical-circuit performance.

Environmentally sealed or unsealed, *AMPin-cert* connectors are made in 50 and 100 position units and have a number of unusual features including: single or dual circuit leads per contact (in the 50 position unit) . . . crimp-on snap-in contacts with extra wire insulation support against vibration . . . aluminum shells for shock . . . cadmium plating for corrosion resistance . . . extended alignment skirts plus alignment bushings on shells to prevent coupling damage to contacts . . . alpha-numerical coding of all cavities.

Get reliable performance under vibration and shock . . . in arid climates . . . in excessively humid conditions . . . in extreme cold or heat. No solder, naturally. Current rating of 5 amperes.

If you need a rugged connector with dry circuit sensitivity, the *AMPin-cert* Rack and Panel Connector is your answer. Send for more information today.

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Services to Exchange Avionic Test Data

By Philip J. Klass

Washington—First details of a tri-service program to exchange reliability test data on avionic components, scheduled to go into operation soon for about 50 major contractors on Air Force, Navy and Army ballistic missile and space projects, were disclosed here during the recent National Symposium on Reliability and Quality Control.

Details on the Interservice Data Exchange Program (IDEP) were scheduled to be mailed to participating companies last week. If the program proves successful, it may be extended to all major defense projects, a Defense Department official told AVIATION WEEK.

Under the IDEP program, each of the major ballistic missile and space projects contractors will send a copy of every avionic component test report it prepares to its cognizant service center. These will be duplicated in the form of microfilm mounted on punched cards and supplied to each of the other interested companies (AW Jan. 18, p. 35).

A Battelle Memorial Institute representative reported on the progress of a similar avionic component data exchange program, started early last year, in which 12 avionics/airframe companies are participating on a voluntary basis.

A newly formed organization known as Columbia University Consultants plans to set up a similar program, it was reported at the symposium.

Partial Answer

These programs to exchange component test data among avionic equipment manufacturers are expected to provide a partial answer to the long-voiced complaint about duplication of expensive and time-consuming testing of avionic components by individual equipment manufacturers.

A former head of the Federal Trade Commission warned that unless extreme legal care is taken in setting up such a data exchange program, it runs the risk of being cited for restraint of trade. This danger exists even if the program is sponsored by the Defense Department or is intended for its ultimate advantage, Edward F. Howrey, former FTC chief, said. He cited as an example the current Justice Department action against a number of oil companies which is based on action which Howrey said was taken at government request during the 1956 Suez crisis.

Several years ago, an Electronic Industries Assn. committee, after studying the component testing problem, recommended a program to exchange test data. However, EIA decided against sponsoring such a program because of possible adverse FTC interpretation.

A dissenting note on the potential value of the component test data exchange programs was voiced by J. M. Glass of Hughes Aircraft Co. He pointed out that the specific environmental conditions and test procedures employed by one manufacturer frequently makes his test data of little value to other equipment manufacturers which are designing for different environments.

Instead, Glass recommended that the Defense Department set up a central organization which would do the following:

- **Obtain component procurement** specifications from avionic equipment manufacturers and the test data used to substantiate the conformance of purchased components to these specifications. Latter should include the allowable component failure rates required by the equipment maker.
- **Set up aggressive standardization** program to revise and promptly prepare new military specifications for component parts, based on contractor requirements (above).
- **Obtain, analyze and publish data** on component failure rate as a function of circuit and environmental stress in a handbook for use by equipment designers.

Another symposium speaker who expressed similar views was J. M. Farrier of Arinc Research Corp., which specializes in reliability matters. Farrier called for the government to set up a central agency with the authority to monitor all testing of components by defense contractors and to compile and disseminate such data in a form suitable for use by design engineers.

The Basic Problem

Many observers believe that the basic problem of component unreliability will not be solved until the process of drawing up MIL specifications is greatly accelerated and provisions are made to provide continuous assurance that a component maker maintains component quality levels.

At present, MIL specifications lag several years behind the needs of equipment designers and the state of the component art. This means that a component manufacturer is required to test a specification which is far less demanding than what his customer requires, which forces the customer to perform his own component testing.

Many component makers are willing, even anxious, to perform more rigorous tests, providing their customers can agree upon a single standard and are willing to pick up the tab. Too frequently each equipment maker comes up with a specification which differs just enough from that of another equipment maker to require separate sets of tests. For example, Julian K. Sprague told the symposium that his company is producing one widely used miniature metal-clad capacitor to 18 different customer specifications. One observer remarked somewhat facetiously that he was surprised it was only 18 and not 180.

A group of industry and government experts has been wrestling with this problem for several years under the sponsorship of J. M. Bridges, director of the Office of Electronics, Office of the Director of Defense Research and Engineering. A specific program to greatly accelerate the preparation and revision of component MIL specifications and to continuously monitor the quality of components at manufacturers' plants

Reliability Payoff

Unlike most complex new systems, a Boeing B-52 bombing-navigation system proved as reliable in its first year of operation as the older K-system (used on early model B-52s) did after seven years of debugging and service, an Air Force spokesman indicated at the recent national reliability symposium in Washington. The reason for this good showing was a specific reliability effort which cost about $4.6 million and was carried out during system development, whereas the older K-system was rushed into production without completing flight tests and without such a reliability program, according to Lt. Col. William F. Stevens, Wright Air Development Division. New system was developed by International Business Machines Corp. A contributing factor was flight testing on pilot models which pointed up improvement in design that led to a 32% improvement in reliability for production bomb-nav systems, Stevens said.

It's the Warhead that makes a missile pay

The tremendous effort that goes into a missile means little unless the warhead functions properly

Man has been trying to produce positive destruction at an exact location for centuries. With help from the vital and complicated systems found in a guided missile warhead, he is coming closer and closer.

Today's warhead system must rely upon highly accurate safing-arming-fuzing devices to guarantee detonation when and where desired. The degree of sophistication in this system is determined by the specific mission. To date there are six programmed missions: air to air, air to surface, surface to surface, surface to air, underwater to air to surface and underwater to underwater.

What's in a warhead?

Warhead system performance is always critical. In order that the device be safe, armed and detonate upon delivery, the safing, arming and fuzing functions must perform as one system in perfectly timed sequence.

The *safing* system maintains the warhead in a safe condition during handling, launching and flight until the missile has reached a safe distance away from the launch site and friendly troops. Designed to prevent arming and fuzing operations until the projectile nears the target area, this system must be flexible. Maximum safety can be provided through utilization of components which sense such things as minimum preset altitudes or missile velocity. Honeywell makes accelo switches, baro switches and timers for safing systems.

The *arming* system will examine the flight path of the missile, define range, cross range and preset altitude dimensions. The arming system will then decide, based on data collected, whether to prepare the missile for self destruction or on-target detonation! Honeywell makes inertial instruments, timers, baro switches and temperature switches for use in arming systems.

The *fuzing* system, using ultra-sensitive pressure, proximity, time or acceleration sensors, assures precise detonation when and where desired. The method of fuzing may be air burst, contact burst or air burst with contact burst as a backup. If the mission is to be aborted due to a malfunction of any missile subsystem or component, the warhead may be dudded almost to the time the fuzing process begins. Another possible action is called destruct, which means the warhead will be harmlessly destroyed high in the air. Honeywell makes infrared, baro switch, timer, radar, electrical or piezo electric, mechanical and hydrostatic fuzes for warhead fuzing systems.

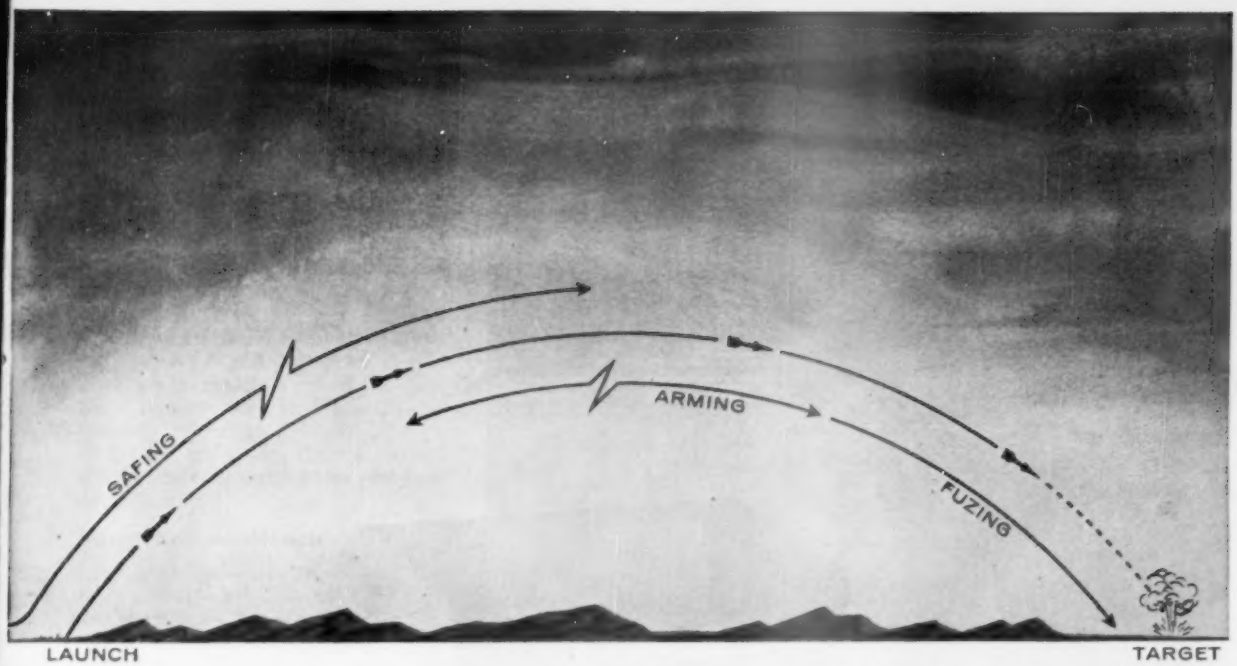
CORPORATE CAPABILITY AND EXPERIENCE

Significant capability stems from a depth of Honeywell experience in inertial systems, gyroscopes, accelerometers, computers, air data systems, ballistic trajectory control systems, horizon scanners, fix takers, pressure and temperature sensors. Honeywell is one of the nation's largest contributors to the entire missile industry as well as to warhead technology. With a notable background in the design, development and production of systems and components, Honeywell is fully qualified for work on all phases of prime missile and space systems management.

For detailed information, call or write Honeywell, Minneapolis 8, Minnesota.

One or more Honeywell warhead systems are on all these missiles:

Redstone Littlejohn Terrier Talos Sidewinder



There are 3 basic systems in a warhead section. *Safing* for storage, launching and flight over friendly territory, *arming* to make warhead capable of exploding, and *fuzing* to assure precise detonation.

GLOSSARY OF WARHEAD TERMINOLOGY

1. Adaption Kit—Those items peculiar to the warhead installation less the warhead; namely, the arming and fuzing systems, power supply and all hardware, adaptors, skins, etc., required by a particular installation.

2. Arming System—That portion of the weapon which derives (originates) the signals required to arm, safe or re-safe the firing system. Will normally consist of accelerometers, arming baros or similar components.

3. Dud Probability—(Warhead Section)—The probability that the warhead fails when launched at a target to produce a nuclear detonation at the desired location.

4. Firing System—That portion of the weapon which, upon signal from the arming system, transforms and stores electrical energy, and upon signal from the fuzing system, discharges this stored electrical energy to detonate the warhead.

5. Fuzing Systems—That portion of the weapon which derives (originates) the signals which discharge the firing system. This system normally consists of such components as pressure, proximity, time or acceleration sensing.

6. Minimum Burst Height—That height above which only an acceptable degree of ground contamination will occur.

7. Premature Probability—The probability that a weapon/warhead explodes before reaching the intended point of detonation in space, including allowable space tolerances.

8. Safe Burst Height—That height above which only an acceptable degree of damage will occur to friendly ground installations.

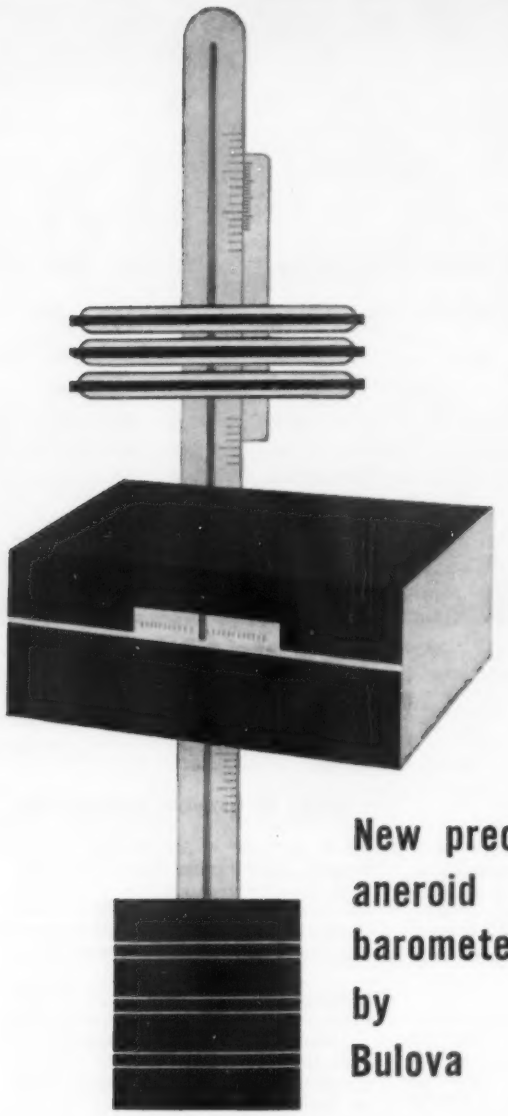
9. Safing System—That portion of a weapon that integrally contains all the apparatus which, on receipt of proper signals from the arming system or by manual operations, functions so as to place the warhead system in an armed or safe condition.

10. Atomic Warhead Section—That portion of an atomic weapon which consists of the warhead and the adaption kit.

Honeywell

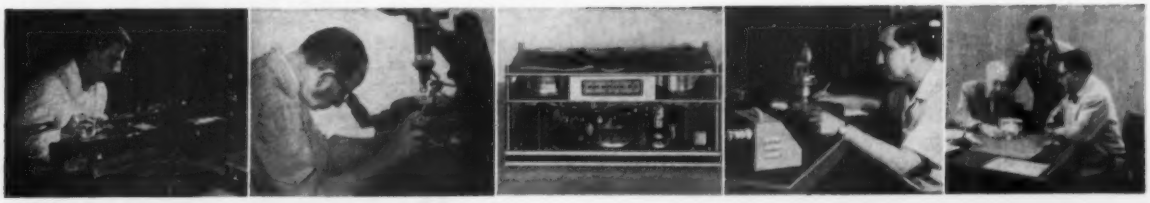
H Military Products Group

Honest John Falcon Lacrosse Sergeant Corporal



New precision aneroid barometer... by Bulova

Bulova barometer sensitive to 0.001" Hg



The Bulova Precision Barometer has advantages over the best mercury types. Easy-to-read tape presents pressure between 21 and 31 inches in thousands. Maximum error: within 0.002"; instrument lag: 0.001" maximum over 3" range.

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is expected to be announced soon.

The newly established Interservice Data Exchange Program has set a modest objective, at least as its initial goal, in the interest of getting the program moving quickly. Each of the three services will establish a component parts data distribution center to receive test reports from its own ballistic missile and space contractors which will prepare a summary card and a microfilm copy of the complete report.

At the start of IDEP, each participating contractor will register with the three service centers a list of the categories of components in which it is interested. Microfilm copies of all contractor test reports for those categories will then be transmitted to the company automatically.

Direct Communication

To speed up operations, each of the service centers will transmit reports it receives directly to interested contractors of all three services, rather than routing them through the other two service centers, according to Martin Barbe, who described IDEP program.

Barbe is reliability coordinator at Space Technology Laboratories.

The question of whether copies of the test reports will also be distributed to the manufacturer of the components involved has not yet been resolved, Barbe said.

When IDEP gets in to full operation, it is expected that the summary cards and microfilm copy of the full test report can be processed and mailed in less than a week after they are received from the originating company, Barbe said.

Initially, the punched card bearing the microfilm copy of the reports will be coded only to indicate the type of component involved, the component manufacturer, the weapon system involved, date of the test report and the type of test involved, i.e. qualification, product acceptance, production monitoring, reliability demonstration, etc. Determining the specific environmental conditions under which the component test was made will require users to refer to the printed summary card or to project the microfilm report and study it. Periodically, a bibliography listing all test reports processed will be issued to participating companies.

However, Barbe reported that a punched card version of the summary card may be adopted which would provide all of the environmental conditions permitting users to employ machine search to locate reports on specific components tested under the specific environmental conditions of interest in their own work.

In the future, the IDEP program

General Electric can build reliable specialty heating devices in any shape, for any application

IF YOUR EQUIPMENT WON'T OPERATE at peak efficiency in extremely low temperatures, General Electric heating devices are the answer. We can design and build reliable heating equipment that will overcome intense cold and maintain uniform surface temperatures.

GENERAL ELECTRIC HEATING DEVICES have been used successfully on most major missile and jet aircraft produced in the United States. Typical applications: maintaining critical fuels at correct temperatures, heating optical, electronic and hydraulic airborne equipment, as well as gyros, d-c amplifiers and batteries.

THIS DEMONSTRATED VERSATILITY includes heaters that will operate and remain flexible at temperatures ranging from −65 F to 500 F. These units can be built as thin as 0.008 inches, and can be supplied in a wide range of wattage densities. Some heating devices weigh as little as 0.05 pounds per square foot. These characteristics can be employed in heaters that must operate in fuels, solvents, or acids. They can incorporate their own thermal insulation, and General Electric can make them in any configuration that's needed.

A G-E SPECIALTY HEATING EXPERT is available to analyze your particular heating problem—assuring you of prompt service and a fast solution.

Contact D. R. Barbour, Manager—Engineering, Specialty Heating Products Section, General Electric Co., Coxsackie, N. Y. (Phone Coxsackie 6-5631), or mail the attached coupon.

142-2

GENERAL ELECTRIC COMPANY
Specialty Heating Products Section
Coxsackie, New York
Please send bulletin GEA-6283A on "G-E Specialty Heating Equipment."

☐ for immediate project
☐ for reference only

NAME_____
POSITION_____
COMPANY_____
CITY_____
STATE_____

Progress Is Our Most Important Product

GENERAL ELECTRIC

TECHNICAL KNOWLEDGE + EXPERIENCED MANAGEMENT + SPECIALIZED CRAFTSMANSHIP = **KNOWMANSHIP**

Knowmanship makes the difference

The technical knowledge that's part of Eclipse-Pioneer's KNOWMANSHIP can work for prime contractors in two important ways. First, as a potent helper in getting the contract. Second, as a positive time- and money-saver in fulfilling that contract.

Take just one "plus" that results from our technical knowledge in the area of production capabilities. By making some Bendix-patented modifications to our battery of Steinel precision boring machines, we have tailored them to our special type of high-precision mass production. Result: We can now bore 136-hole pieces *without limitation on center distances, to 0. 0002" hole and location tolerances and to bore size limits of* $+.^{0002"}_{-.000"}$ *in an average time of ten minutes, with no scrap.*

This is typical of the kind of performance that accrues to "primes" with E-P KNOWMANSHIP on their teams. And it is typical of why we are able to design and build better, lower cost, and more accurate sub-systems for modern weapons. Isn't this exactly the kind of ingenuity and creativity you want on *your* contracting team? Call, wire, or write for the full KNOWMANSHIP story as it applies to any of the product areas listed below.

69% of E-P's procurement dollars go to small business.

ECLIPSE-PIONEER

TETERBORO, N. J. DIVISION of Bendix AVIATION CORPORATION

AUTOMATIC FLIGHT CONTROL • CENTRAL AIR DATA SYSTEMS • SPECIALIZED INSTRUMENTATION • NAVIGATION COMPUTERS AND DIRECTORS
STABLE PLATFORMS • INERTIAL GUIDANCE • RADAR ANTENNA STABILIZATION AND TRACKING SYSTEMS • GROUND SUPPORT EQUIPMENT

F8U-1P Photographs Manhattan at 50,000 ft., 800 Kt.

Manhattan Island, as photographed from a Navy Chance Vought F8U-1P jet reconnaissance carrier-based aircraft flying at an altitude of 50,000 ft. and speed of about 800 kt. Photo was taken by Chicago Aerial Industries KA-30 aerial reconnaissance camera using 5 in. film to produce 4½ x 4½ negatives.

may be expanded to include summaries and surveys of particular areas of interest, Barbe said.

The Electronic Component Reliability Center (ECRC), which Battelle set up last spring, goes a step beyond the tri-service IDEP in that it analyzes and evaluates the reliability test data submitted by the participating companies, as well as conducting research in reliability techniques, C. R. Deeter told the symposium.

The 12 companies now participating in the program include: Bell Telephone Laboratories, Boeing, General Dynamics, General Precision Equipment, Hughes Aircraft, International Business Machines, Lockheed, Martin, Motorola, Northrop, Radio Corporation of America and Raytheon. Each company pays an annual fee of $20,000 to participate.

Each of the companies submits to Battelle its final component test reports plus the raw data upon which they are based. These reports then are analyzed and correlated with test results on similar components by other members of the group. Battelle then prepares a summary report for all members.

In November, Battelle issued its first report, on transistors, based on results of 230 individual member test reports. The second report, on diodes, was issued last month. Reports on capacitors and relays are due in February, Deeter said. More than 450 individual test reports have been analyzed for the report on capacitors.

Battelle Summary

In the Battelle summary reports, names of the component manufacturers are indicated only by code which participating members are obligated not to divulge to outsiders. The company which contributed specific data in the summary is known only to Battelle's ECRC employes. All test reports are locked in cabinets and are not available to other participating corporate members of the program, Deeter said.

About 20% of the funds paid in by group members goes for research in the field of reliability, Deeter said. During the initial year, this effort was directed toward development of a methodology for more effective screening of incoming parts, applying linear discriminant analysis to carefully controlled experiments. Battelle seeks to determine what parameters are relevant to part reliability, the minimum number of parameters suitable for screening and how this screening procedure can be optimized, Deeter said.

Each member company designates a corporate technical representative who attends bi-monthly meetings and has the authority to make technical program decisions. Each member firm also has a corporate legal representative; sometimes the same person serves in both capacities.

The ECRC contract provides that group members will vote on certain legal matters pertaining to group membership and patents. The technical program is controlled by Battelle and not

HOW TO SELECT HIGH RELIABILITY CAPACITORS

At one time Sprague Electric was the only manufacturer offering true high reliability capacitors. The buyer had no problem. But today there are many manufacturers who claim that their capacitors meet high reliability standards. Some are even so bold as to claim that theirs are *the most reliable.*

Check the record before you choose

The only sound approach to evaluate these claims is to investigate the *reliability record* achieved by each of the companies under consideration. Remember, it takes test data to establish the reliability of a product. Claims are not enough.

Now let's look at the record

Sprague Electric can substantiate its claim that its HYREL® Q Capacitors are "the most reliable capacitors made" with the most extensive test data available in the entire electronic industry. The performance of HYREL Q Capacitors is virtually impossible to surpass . . . now and for some years to come.

But let's start at the beginning—*the specifications.* Sprague Electric's high reliability capacitors were originally made under Sprague Electric Specification PV-100—*the first high reliability capacitor specification for missiles and other critical applications.* This specification and a later revision, PV-100A, have proven so comprehensive and so successful in providing "the highest order of reliability known to capacitor manufacturing" that their provisions are currently reflected in *every* military specification covering high reliability capacitors. This is a distinction shared by no other capacitor manufacturer.

Now look at the record of HYREL Q Capacitors

On accelerated life tests the failure rate of HYREL Q Capacitors has been less than 0.05%, after more than 16 million unit hours accumulated on tests of 250 hours at 140% rated voltage, 125 C. On high frequency vibration tests, there hasn't been a single failure in the more than 50,000 units tested. On seal, moisture resistance, and temperature cycling and immersion tests, the failure rate has been less than 0.1%.

Such performance from production line capacitors can only be achieved through the most intensive (and expensive) kind of reliability program—in design and development, in production engineering, in manufacturing facilities, in testing intensity and extensity—all of which should be investigated thoroughly.

After you've checked the record, then decide for yourself which capacitor is "the most reliable made."

For complete facts and figures on HYREL Q Capacitors, call your Sprague District Office or Representative, or write for HYREL Bulletin 2900A and Specification PV-100A to Technical Literature Section, Sprague Electric Company, 327 Marshall St., North Adams, Massachusetts.

by vote of the members. Naturally, Battelle tries to be responsive to the needs of its members.

The contract states that new members can be admitted to the ECRC program by a majority vote of the members, but members have voted in advance to admit any company which Battelle approves for membership.

Trend toward incorporating quantitative reliability requirements into the specifications for new avionic equipment poses a serious problem for designers and manufacturers because of the lack of reliable data on component life expectancy under various environmental conditions, John M. Farrier of Arinc Research Corp. told the symposium.

Failure Rate Disparities

Because component failure data is obtained from a variety of sources, ranging from field data to laboratory tests, there is a wide disparity between the values of life expectancy obtained, Farrier pointed out. For example, failure rates measured on capacitors per thousand hours have been as low as 0.00025% and as high as 15%, a 60,000:1 variation.

Relay failure rates measured range from 0.005% to nearly 26%, a 500:1 variation.

The solution of this problem does not necessarily require additional testing so much as it requires coordination and standardization of the vast amount of component testing already conducted by component and equipment manufacturers, Farrier indicated.

Farrier proposed a central agency which would coordinate test programs of all defense equipment and component manufacturers, standardize on test and data measurement procedures. Central agency would also use the accumulated data to develop stress-factor curves which would relate failure rate to the environmental and circuit conditions in which component is used. The agency also would prepare a component application manual for use by design and reliability engineers. The handbook would be published in looseleaf form to permit introduction of revisions and new data.

In response to an AVIATION WEEK query as to whether Arinc Research Corp. would be interested in serving as such a central coordinating agency, a company official smiled and said: "reliability is our business."

The Sixth Annual National Symposium on Reliability and Quality Control had a record attendance of nearly 1,200 persons, including representatives from Canada, England, Germany, Holland, Italy and Japan. Symposium was sponsored by American Society for Quality Control, American Institute of Electrical Engineers, Institute of Radio Engineers and Electronic Industries Assn.

PPI Recorder

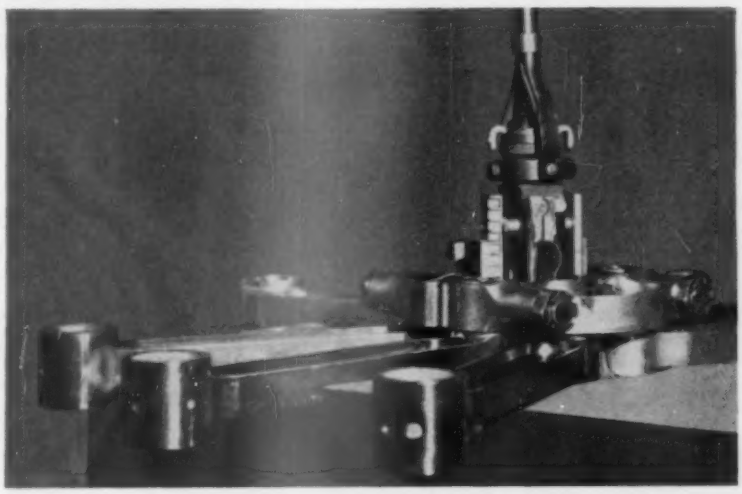
Washington—Thermoplastic plan-position indicator (PPI) recorder, scheduled for delivery to U. S. Navy in April, 1961, is expected to be one of the first developmental equipments involving the new thermoplastic recording process (AW Jan. 18, p. 87) to be delivered to a military service.

The PPI recorder is being designed to take information normally displayed on a PPI radar scope, record it and project a 6 ft. x 6 ft. image onto a vertical screen 20 ft. away.

Design objectives demand sufficient display brightness for use in normal ambient lighting. Gun resolution must be compatible with a 1,000-line display.

Instead of feeding a cathode ray tube, the output of a radar receiver will modulate a thermoplastic recording gun. Large, bright images can then be projected within fractions of a second.

This work is being done as part of a $450,000 Navy Bureau of Ships contract awarded last spring to the Heavy Military Electronics Department of the General Electric Co. at Syracuse, N. Y.



Taking The Stress Out Of A Master Rod

A properly fitted link pin sets up enough internal stress in the master rod bores to bulge the crank shaft bearing area very slightly. These bulges are so small they are almost impossible to detect. But they sometimes set up enough stress to crack the master rod bore during the engine's operating cycle. Master rods are expensive to replace.

This simple Airwork "extra" sharply reduces the danger of bore cracking. After the link pins are in place, Airwork uses an electric hone to eliminate the tiny internal bulges created by pin pressure. Then we make sure the bearing area is perfectly circular after the pins are in place.

It takes only a few extra minutes to hone a pre-assembled master rod to perfect roundness . . . but it adds a lot to the satisfaction you get from a smooth running, long lived Airwork overhauled engine. Airwork saves you time and trouble by doing more work at overhaul, *when it can be done at low cost* and no inconvenience to you. Give your engine an Airwork overhaul—and be sure of maximum operating satisfaction.

Airwork CORPORATION
Millville, New Jersey

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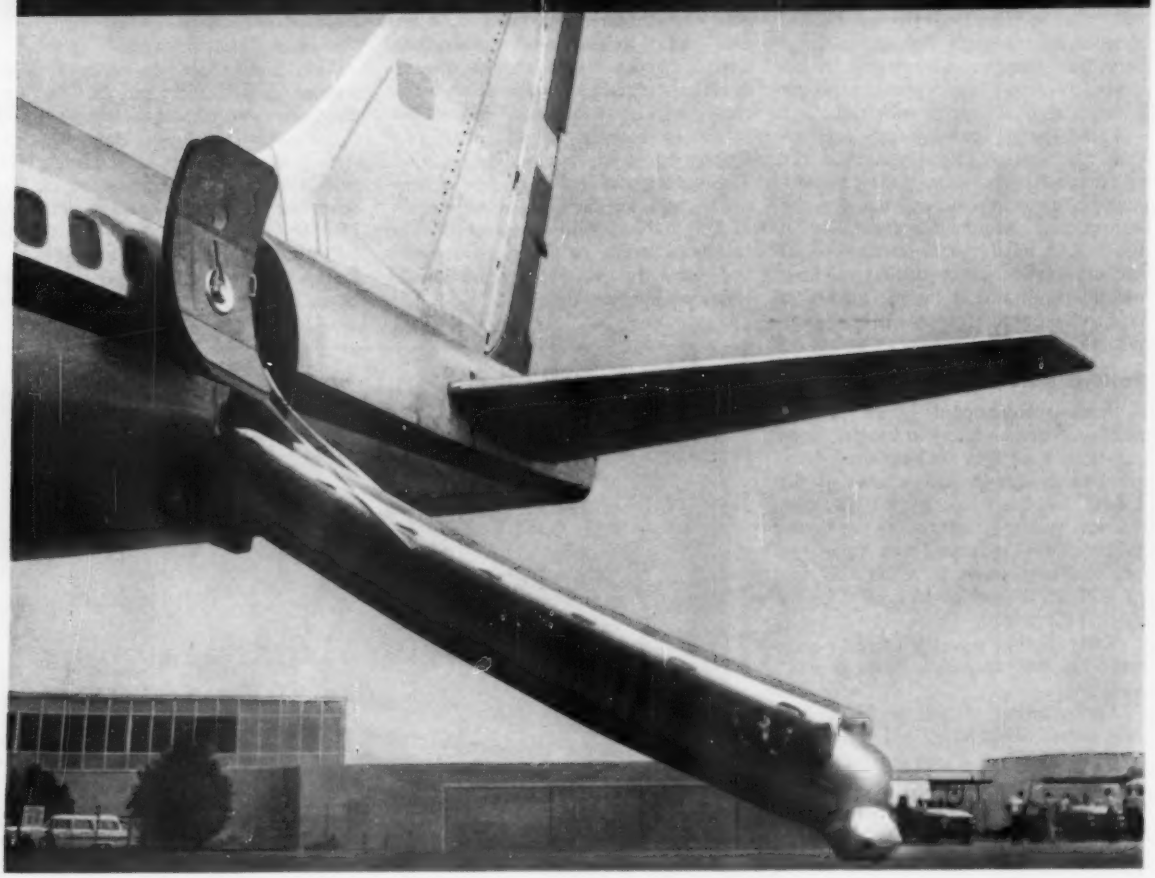
ESCAPE SLIDE / another product of Air Cruisers research



DEPENDABLE SURVIVAL EQUIPMENT

The Air Cruisers escape slide shown here assists passengers and crew to evacuate the aircraft in an emergency in a matter of seconds without injury. Simple to operate, it is standard equipment on most turbine-powered passenger aircraft.

Thoroughly tested by the military and commercial airlines, the inflatable escape slide is another major achievement in a field where Air Cruisers has been the leader for more than 30 years...dependable, lightweight survival equipment. The only manufacturer which conducts continuous research in survival equipment, Air Cruisers is America's most experienced fabricator of inflatables from rubberized nylon materials.

The Air Cruisers jet pump, which produces the rapid inflation vital to the fast, dependable operation of the escape slide, is another contribution toward better survival equipment. Today, more products, including life rafts, deceleration bags, etc., are inflated by Air Cruisers jet pumps than by any other kind.

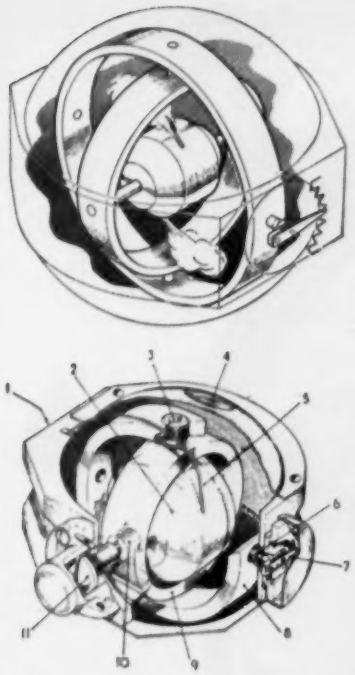
Your inquiries are invited.

THE GARRETT CORPORATION

AIR CRUISERS DIVISION

BELMAR, NEW JERSEY

LIFE JACKETS • LIFE RAFTS • HELICOPTER FLOATS • ESCAPE SLIDES • GAS BREATHER BAGS • DECELERATION BAGS



PYROTECHNIC GYRO for small tactical missiles has its rotor spun at high speed by discharge gases from electrically ignited cordite charge. New gyro will be produced by Giannini Controls Corp. of Pasadena, Calif. Cutaway view of pyrotechnic free gyro at bottom shows: 1—mounting face; 2—rotor; 3—inner gimbal pivot; 4—blowout window; 5—ignition wire extraction spring; 6—outer gimbal pivot; 7—pickoff; 8—outer gimbal; 9—inner gimbal; 10—rotor bearing pivot; 11—gimbal release device.

Giannini to Produce Pyrotechnic Gyro

Pasadena, Calif.—Pyrotechnic gyro for small tactical missiles, whose rotor is spun at speeds up to 36,000 rpm. by hot gases from an electrically ignited cordite charge, will be manufactured by Giannini Controls Corp., Pasadena, Calif., under a licensing agreement recently signed with Short Brothers and Harland, Ltd., Belfast, Ireland.

The pyrotechnic gyro, which will be produced in both free and rate gyro types, reportedly reaches top speed within 0.1 sec. after charge ignition and coasts for approximately 40 sec. afterward.

The pyrotechnic gyro is expected to compete with spring-wound gyros for small missile applications. Giannini says the pyrotechnic gyro, which weighs 0.5 lb., will be lighter, smaller and less expensive than spring-wound gyros and it predicts the new gyro also will be more reliable.

Giannini expects to be producing the British pyrotechnic gyro in quantities by the latter part of the year.

Both the rate and free gyro types have a maximum rotor angular momentum of 3.5×10^5 gm. cm.^{2} per second. Maximum drift rate of the free gyro is quoted at 3½ deg. per minute. The rate gyro has a maximum rate indication of 75 deg./sec. initially, rising to 130 deg./sec. after 40 sec. of operation. Its undamped natural frequency is 33 cps.

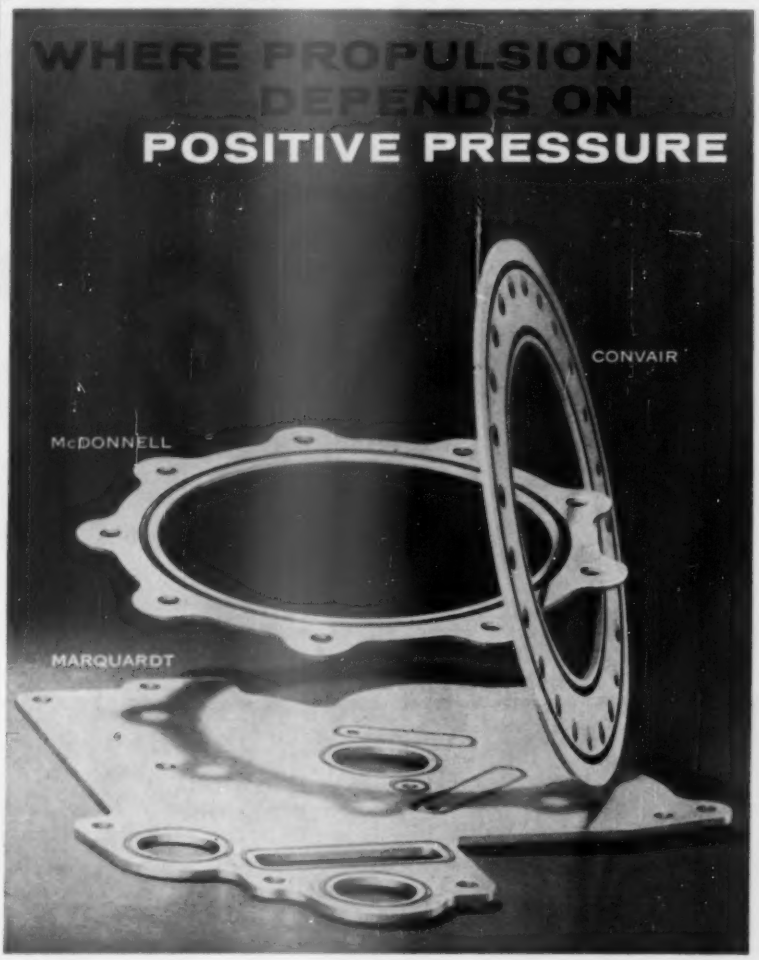
Viscous damping provides a damping factor of 0.4 to 0.6 at 20C.

Company's address is 918 East Green St., Pasadena, Calif.

FILTER CENTER

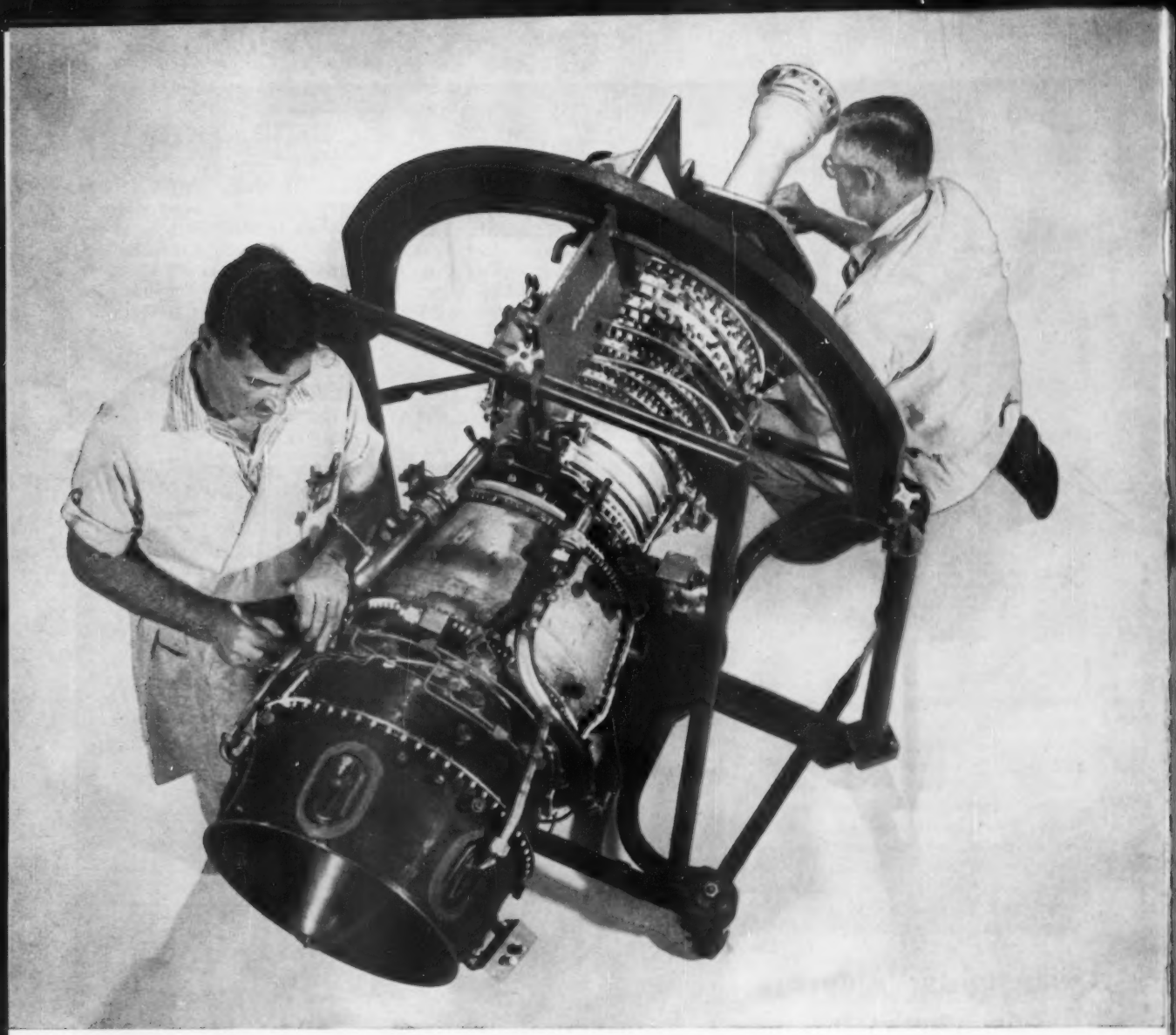
▶**Precise Microwave Attenuation** — Method for calibrating lower ranges of a microwave attenuator to accuracies better than 0.0001 db. has been developed by National Bureau of Standards. Technique employs an amplitude-stabilized microwave signal source and a bolometer detector operated in a temperature-stabilized water bath.

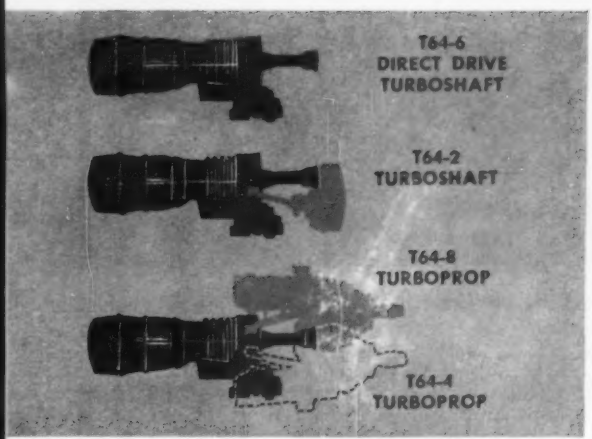
▶**USSR Computer Uses** Three-Digit Code—Moscow State University has



Stillman meets "Space Age" requirements with the same reliability and product perfection that has earned them a name for dependability throughout the aircraft and missile industry for many years. Stillman products fly with the jets. They are also integral parts of the fuel and hydraulic systems for many of the advanced weapon systems. Engineering, research and development, and progressive designing enable Stillman to meet the challenge of the space age.

STILLMAN RUBBER COMPANY
CULVER CITY, CALIF. / CLEVELAND, OHIO / ENGLEWOOD, N.J.





BUILDING-BLOCK DESIGN is a principal feature of the T64 engine. Turboprop configurations are obtained by the simple addition of reduction gearing to the basic turboshaft engine. This means standardization of parts and simplification of logistic support for users.

LOW SFC AND HIGH POWER-TO-WEIGHT RATIO make the General Electric T64 turboshaft and turboprop engines ideal powerplants for many military and commercial aircraft including STOLs, helicopters, skycranes and other VTOLs. These are illustrated above in a composite artist's drawing.

FROM GENERAL ELECTRIC...

PIONEER AND LEADER IN SMALL AIRCRAFT GAS TURBINE PROGRESS

T64 turboshaft/turboprop: 2600 hp-class engines for tactical and support aircraft will be flight qualified and available this year

Airframe manufacturers and military and commercial aircraft users requiring economy of operation and high performance, will find these features in General Electric's T64 gas turbine powerplants.

OUTSTANDING PERFORMANCE

Turboshaft T64: 2650 SHP—0.506 SFC—713 lbs
Turboprop T64: 2570 ESHP—0.522 ESFC—1079 lbs

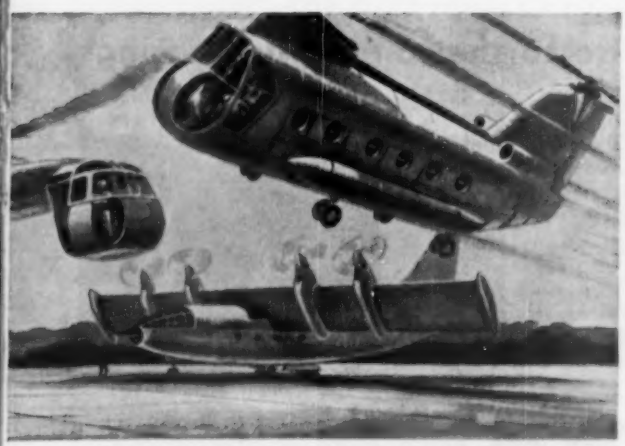
. . . and the same basic power unit, including controls, is common to all T64 configurations. Superior missions including greater payload, speed, range and economy for support and tactical aircraft can be obtained by utilizing the low specific fuel consumption and attractive power-to-weight ratio of the T64.

INSTALLATION FLEXIBILITY—With designed-in ability to operate continuously at attitudes from 100° above horizontal to 45° below, the T64 engines are ideal powerplants for VTOL and STOL aircraft. Featuring compact engine size, split casings and grouped accessories, the T64 is designed for easy installation and maintenance.

EARLY AVAILABILITY—The T64 engine development program has been on schedule since its inception. The first official test runs of both the turboshaft and turboprop engines were completed ahead of schedule in early 1959 and the rapid pace is continuing. From the user's standpoint, this T64 development progress means that flight qualified engines are scheduled for availability in 1960.

FOR MORE INFORMATION—Brochures are available that describe the T64 engine in detail. If you would like this information, write Section 233-31, General Electric Co., Schenectady, New York.

T64 RELIABILITY will go hand in hand with outstanding performance. A unique government contract which calls for 10,000 hours of engine running by the time all configurations of the engine are qualified will help assure both reliability and performance for the T64 engine.



Both fuselage and wing-mounted installations are possible with the various configurations of General Electric's T64 engine. This flexibility plus T64 high performance can provide important benefits to aircraft manufacturers and users.

GENERAL ELECTRIC

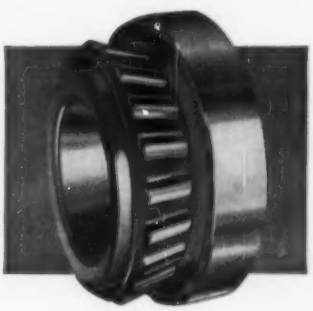
General Electric's Small Aircraft Engine Department also produces the T58 and CT58 turboshaft engines for military and commercial helicopters, the J85 turbojet engine for aircraft, missiles and drones and is presently developing the new CF700-1 turbofan engine for medium and light weight aircraft. These engines are a part of G.E.'s growing flight power spectrum with over 25 million hours of accumulated flying time.

STAMINA . . . heavy loads go farther on Bower Bearings

Moving a missile from coast to coast takes bearing muscle aplenty. And its on-schedule arrival depends on perfect —repeat, *perfect*—bearing performance.

To roll the load surely, safely, on time you can depend on Bower bearings. The extra assurance, extra service they give results from definite design advantages. Spherically generated roll heads, higher flanges and larger two-zone contacts translate into trouble-free service, reduced maintenance, longer bearing life.

Whether you build, buy or maintain trucking equipment—or *any* product that uses roller bearings—ask for Bower first. You can select from a complete line of tapered, straight and journal roller bearings for every field of transportation and industry.



BOWER ROLLER BEARINGS

Bower Roller Bearing Division • Federal-Mogul-Bower Bearings, Inc. • Detroit 14, Michigan

constructed a digital computer that employs a three-digit instead of conventional two-digit (binary) counting system. In addition to "0" and "1," Soviet machines uses "minus-1." Soviets say the tertiary system provides greater computing speed, greater reliability and permits reduction in computer size. Machine is named Setun for a river which flows near Moscow State University.

▶ **Energy Conversion Studied**—Recent work on techniques, materials and devices for avionic equipment power converters include the following developments:

• **Alternating current** thermionic converter generates 100-kc. a.c. directly from cesium diode thermionic converter, according to General Atomics Division of General Dynamics Corp. Firm declined to explain how a.c. is generated from diode converter which normally produces d.c. by boiling electrons off cathode and collecting them at anode. Known methods of direct conversion to a.c. require application of external magnetic field to guide particle flow or variation of injection rates of cesium added to reduce space charge.

• **Alternating current** thermionic conversion technique, studied at Radio Corp. of America, modulates current by boosting anode temperature above 500C from usual 100 to 300C range. One explanation says technique rests on fluctuations at frequencies determined by transition time of ions between cathode and anode. Outputs between 100 kc. and 700 kc. are possible, and device efficiency is halved as it is in other internal modulation schemes.

• **Rare earth semiconductors** in early research stages may have application in thermoelectric power conversion. Group VI compounds made with rare earth metals such as gadolinium, yttrium, erbium and lanthanum show high thermoelectric power which appears temperature independent over wide range, according to Battelle Memorial Institute. Gadolinium telluride and lanthanum telluride were tested up to 450C and 525C respectively. Some compounds show rectifying properties, but possible diode and transistor applications are many years off. Rare earth semiconductors show promise, but they are at development stage where silicon and germanium were more than 10 years ago.

• **Carbox fuel cell** will be developed by Pratt & Whitney Aircraft in joint program with Leesona Corp., formerly Universal Winding Co. Agreement extends original pact on Hydrox fuel cell to cover all fuel cell types with emphasis on Hydrox and Carbox. Pratt & Whitney will handle mechanical and systems development, manufacture and sales. Leesona and National Research Development Corp. of London will

This is the SWAMI MOTION DETECTOR, a compact practical detection device for Perimeter Protection, Plant and Area Security.

NEW "POCKET RADAR"

Sensitive, dependable, inexpensive and completely portable (it's small enough to fit into an attache case). *Where can you use it?*

The SWAMI MOTION DETECTOR is a new low-cost intrusion detector system that saturates a secured area with ultra high radio frequency energy sensitive to the slightest motion or displacement of an intruder. It is fail safe, simple to install, easily operated. And, it is virtually impossible to confound with counter-measures: any tampering will cause an alarm.

Effective Range: From inches to hundreds of feet, with a single unit. Surveillance can be maintained over a full acre, economically.

Flexibility: It can function as an omnidirectional or directional system, and can determine relative or absolute speeds of moving targets.

Durability: The sensor unit of the SWAMI MOTION DETECTOR is shock-resistant, and its service life compares favorably with that of conventional vacuum-tube detection devices.

Power Supply: Standard 115-volt outlet current or any battery-supply DC. *Write for free brochure to:*

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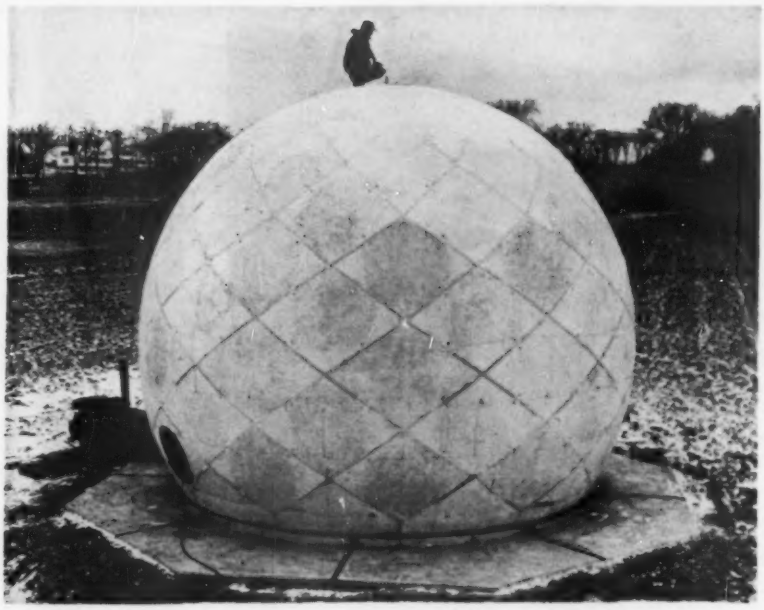


Radome Utilizes Polyurethane Foam Panels

Polyurethane foam radome, erected at Ottawa, Can., by Canada's National Research Council, is said to minimize energy loss and boresight error in radar tracking installations through high "transparency." The radome was molded by Long Sault Woodcraft, Ltd., using panels of polyurethane foam composed of Hentrofoam 10 resin, a product of Hooker Chemical Corp., Niagara Falls, N. Y., and covered with a nylon skin surface.

push chemical and electrochemical research.

▶ **Signed on the Dotted Line**—Major contract awards recently announced by avionics manufacturers include:

• **Beckman Instruments, Inc.,** Fullerton, Calif., $380,000 Army Signal Corps contract for development of high speed data reduction facility to be installed at Army Electronic Proving Ground, Ft. Huachuca, Ariz.

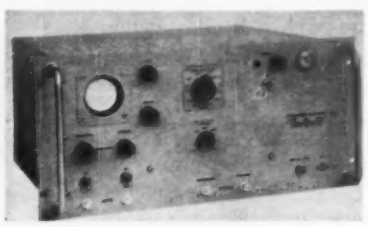
• **Packard-Bell Electronics Corp.,** Los Angeles, will develop a UHF ground-air-ground radio receiver providing 3,500 channels, under $250,000 contract awarded by Air Force.

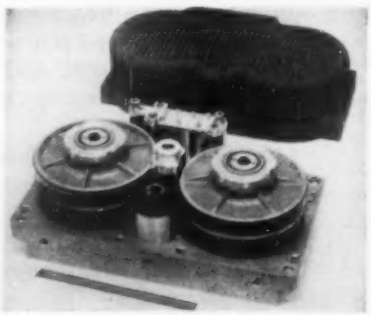
NEW AVIONIC PRODUCTS

Instruments

• **Frequency standard,** Model 100ER, provides stability of 5/10^{9} parts per week and 3/10^{9} over short intervals and offers six sinusoidal signals ranging by factors of 10 from 10 cps. to 1 mc. and four pulse signals from 10 cps to 10 kc. Standard has timing comb for calibrating and for measuring sweeps and time intervals, and built-in scope for comparing Lissajous figures. Rated load is 50 ohms at 100 kc. and 1 mc. and 5,000 ohms at lower frequencies.

Unit, priced at $900, is 8¾ in. high, 19 in. wide, 18 in. deep and weighs 35 lb. Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif.



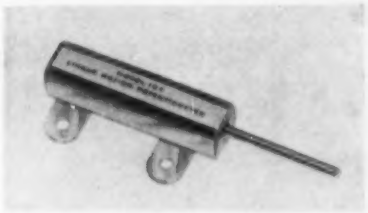


• **Tape recorder,** Model MTR-1200, completely self-contained and needing only 400-cps., 115 v. external supply, offers high reliability under environmental extremes, according to manufacturer. Tape length choice offers either 650 ft. of 1 mil Mylar tape or 800 ft. of ¾ mil pre-tensioned ¼-in. or ½-in. wide tape. Record time is 130 sec. at 60 ips. to 8¾ hr. at 0.25 ips. Unit has 7 or 14 in-line channels, 3 recording heads, measures 10⅜ in. long, 5¾ in. wide and 4⅞ in. high, weighs 10 lb. 2 oz., can start and reverse in less than ½ and 1 sec., respectively, and can operate between −50 and 200F. Leach Corp., 18435 Susana Road, Compton, Calif.

Components & Devices

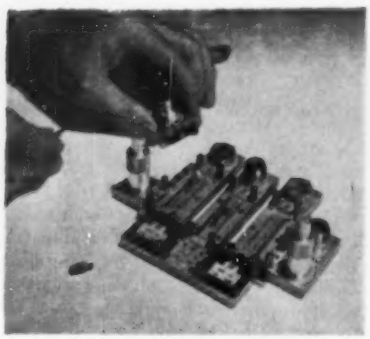
• **Millimeter wave diode,** 1N2792, geramium point contact device mounted in RG 98/U waveguide section, is suited for mixer functions at 70 kmc. Designed primarily for radar and space communications applications, it can also be used in EHF video detector applications. Crystal noise figure maximum of 13 db. assures low-noise performance at 70 kmc., firm says. Available in design quantities; production quantities offered for delivery in March. Philco Corp., Philadelphia, Pa.

• **Potentiometer,** Model 157, a linear motion unit, available with single or dual outputs operates up to 2 kc. under 40g vibration with less than ½% error. Pot has ½, 1 and 1½ in. standard travel ranges, resistances of 1 to 20 kilohms,



a power rating of 1.5 w/in. at 40C and can operate from minus 65 to 374F. Designed primarily for missile applications, it weighs approximately 1.2 oz. and has self-aligning shaft for measuring linear displacement. Bourns, Inc., P. O. Box 2112, Riverside, Calif.

• **Strip line modules,** L-band additions to Tri-Plate line, will mate with broadband transitions, power dividers, right angle vertical and horizontal bends and



other components now used with existing Tri-Plate modules at higher and lower frequencies. Sanders Associates, Inc., 95 Canal St., Nashua, N. H.

Portraits of PERFORMANCE

Two rousing tributes to the performance reliability of CECO products are the remarkable records being compiled by the jet airliners pictured above in "gallery display"—the Boeing 707 and Douglas DC-8.

Main fuel pumps for the Pratt & Whitney Aircraft engines powering each were engineered and precision-produced by Chandler Evans. Significantly, during the first exciting year of U.S. commercial jet operation, CECO pumps took part in every single service mile flown by either type of aircraft.

If pictures of missiles and aircraft which are airborne with CECO products actually *were* exhibited in a gallery, the section devoted to pump applications would be an impressive one. In addition, space would have to be set aside for future portraits, since right now . . . at Chandler Evans . . . a number of important pump design and development programs are underway.

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THE TWO-SEATER ACE

Out of the mist they came, four in front and five behind. Andy McKeever swung his lone Bristol Fighter into position and put the torch to one of the German flight leaders with a burst of 10 rounds. He bagged the next plane head-on. As the German staggered and started to fall, McKeever's observer scored a third kill. In less than 30 seconds, three enemy planes were falling through the air.

Deep in enemy territory, most pilots would have called it a day. Instead, McKeever turned to meet a second attack by the six regrouped Germans. He shot down a two-seater with his first burst, and as the sturdy Bristol passed through the enemy formation, the British observer crippled another German.

But the fight was over. The Bristol two-seater had lost its guns to enemy fire. Playing dead, McKeever flipped his riddled ship over into a side-slip and shot toward earth. Barely 20 feet above the ground, he flattened out and hedge-hopped for home through nearly 60 miles of machine gun and rifle fire.

The date was November 30, 1917. What had started out as a dangerous reconnaissance mission during the battle of Cambrai ended as one of the most heroic exploits of World War I flying.

Canadian-born Major Andrew E. McKeever was awarded the Distinguished Service Order, which he added to his Military Cross and Bar. His observer, Lieutenant L. F. Powell, also was decorated.

McKeever had gone to France with a Canadian infantry brigade early in 1915. After applying nine times for transfer to the Royal Flying Corps, he finally was sent to England for flying instruction.

Early in 1917 he was assigned to No. 11 Squadron, which had just been equipped with Bristol Fighters. It was a gloomy squadron. All but one of the first flight of Bristols to arrive in France had gone down before the guns of von Richthofen's Flying Circus while on their first patrol over the lines.

McKeever, though inexperienced, contended that the Bristol should be maneuvered as a fighter, not as a reconnaissance plane. He backed up his idea by taking the offensive and shooting down two Albatross D-3's in two days. In less than three weeks after his first kill, a spectacular triple victory made him an ace. On December 2, 1917, he scored his final kill—No. 30—and was recalled to England to head a training school for Bristol pilots.

The Bristol F2-B was what McKeever called a pilot's plane. Its armament consisted of a Vickers synchronized machine gun concealed beneath the engine cowling and fired through a hole in the nose, and either one or two Lewis guns mounted on the observer's cockpit. The Bristol was powered by one of several engines: a 200-hp. Sunbeam Arab; a 200-hp. Hispano-Suiza; or a 275-hp. Rolls-Royce Falcon III, which provided a top speed of 125 mph. at sea level.

The ship was destined to survive the ace who made it famous, for in a modified form it served in Royal Air Force training units until 1932. On Christmas day, 1919, Andy McKeever was killed when his automobile skidded on an icy road near Toronto. The ace who had revolutionized two-seater fighting tactics on the Western Front was dead at the age of 21.

MAJ. A. E. McKEEVER
...30 victories from the front cockpit

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One of the most inspiring chapters in the history of technical evolution is the story of the men and flying machines of World War I. It is the highly personalized story of brave men—and the wood, wire, linen, and rudimentary technologies that converted manpower to airpower. Today, Leach Corporation celebrates its 40th year in electronics with the presentation of this Heritage of the Air series.

* * *

Technical Director for Heritage of the Air is Major Kimbrough S. Brown, USAF.

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Operational expansion has created openings for additional senior engineers. Write to W. W. Gordinier, Personnel Manager.

Turbine Super Broussard to Fly in Spring

By Barry Tully

The MH-260 Super Broussard, Avion Max Holste's twin turboprop successor to the single-engine Broussard aircraft, will make its first flight this spring. An experimental prototype of the aircraft, the MH-250, powered by two Pratt & Whitney R1340 engines, first flew at Holste's Rheims, France, facility on May 20, 1959.

The 23-passenger aircraft, considered a low capacity Douglas DC-3 replacement, is intended to provide feeder service for both passengers and cargo in localities which do not generate enough traffic to justify the use of larger aircraft. In keeping with this design philosophy, the Super Broussard (AW June 1, p. 39) is built for operation from small, unimproved airfields.

Super Broussard production will be handled jointly by Max Holste and Nord Aviation. The agreement between Holste and Nord was prompted by a lack of production facilities at Holste's Rheims factory and available plant space at Nord's Meaulte facility due to the phasing out of the Noratlas aircraft. Holste will build five government-financed preproduction aircraft and Nord will enter the scene for production run.

Present plans call for Nord to produce about 80% of the airframe with Holste handling final assembly and flight test. The company says that it has about 50 civil orders ready to be signed. The "subject to change" price of the equipped Super Broussard is $225,000.

Possible Powerplants

The twin-engine MH-260 is engineered to accommodate either the French Turbomeca Bastan, the British Bristol-Siddeley P182 or the Lycoming T53 turboprop engines. Power range offered by these engines is from 750 to 1,000 hp. each. The preproduction aircraft will be powered by Bastan engines. Holste favors the Lycoming T53 as the most suitable for the MH-260, but the French Bastan engine is also a strong contender.

The Super Broussard is conventional in appearance with a high wing, single fin and rudder and tricycle landing gear. The aircraft is designed to cruise at 200 kt. with a maximum endurance of about 3 hr. plus reserves.

The flight deck of the MH-260 is conventional with dual flight controls and dual flight instruments. Engine instruments are grouped in the center of the panel and are visible from either seat. Engine controls are located on a center pedestal along with the trim tabs. Both flight controls and trim tabs on the aircraft are completely manual.

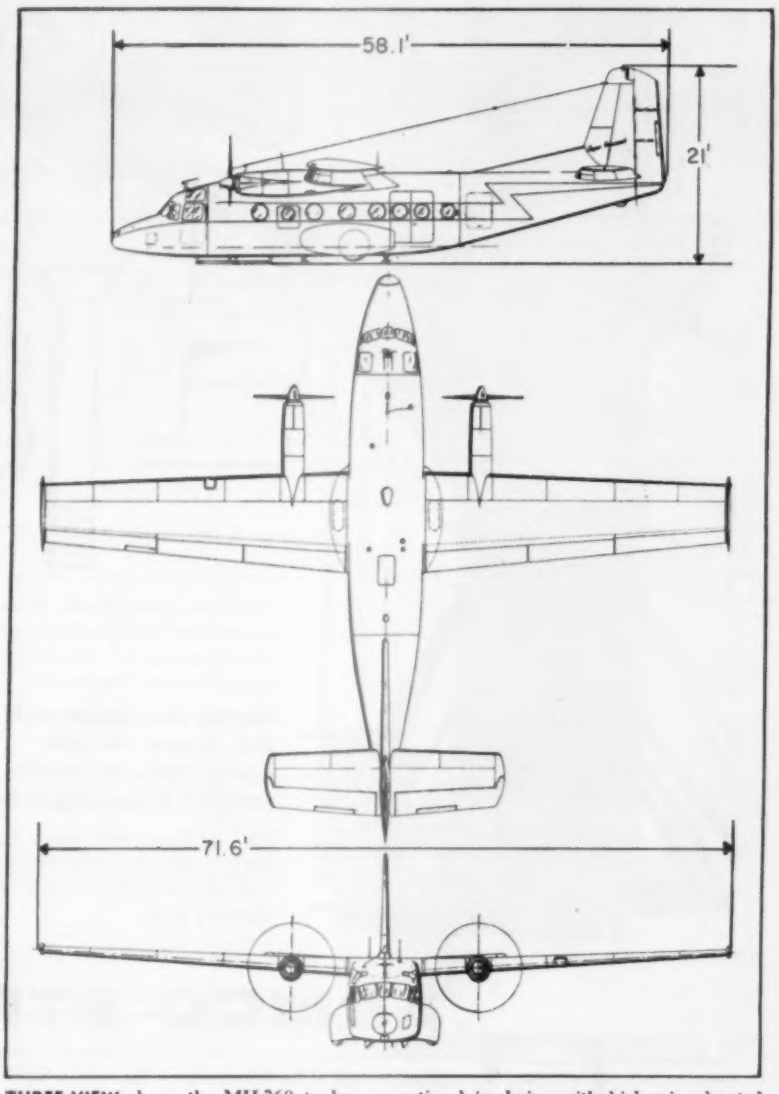
Directly behind the pilot's compartment is the general equipment compartment containing the radio and electrical gear.

The right side of this compartment may be fitted to serve as a galley or as a passenger baggage rack.

The fuselage of the MH-260 is rectangular with curved sides throughout the cabin section. It becomes ovoid toward the tail. The aircraft is not pressurized.

Passenger Cabin

The passenger cabin of the Super Broussard is normally provided with 23 seats—8 twin seats and 7 single seats. A very high density configuration is possible, seating 30 people. This requires the use of four-passenger bench type seats. A de luxe 17-passenger configuration will also be offered. The cabin has 12 windows, two of which serve as emergency exits. An ad-



THREE-VIEW shows the MH-260 to be conventional in design with high wing located midway aft on the fuselage. Aircraft is 6 ft. longer than piston engine prototype.

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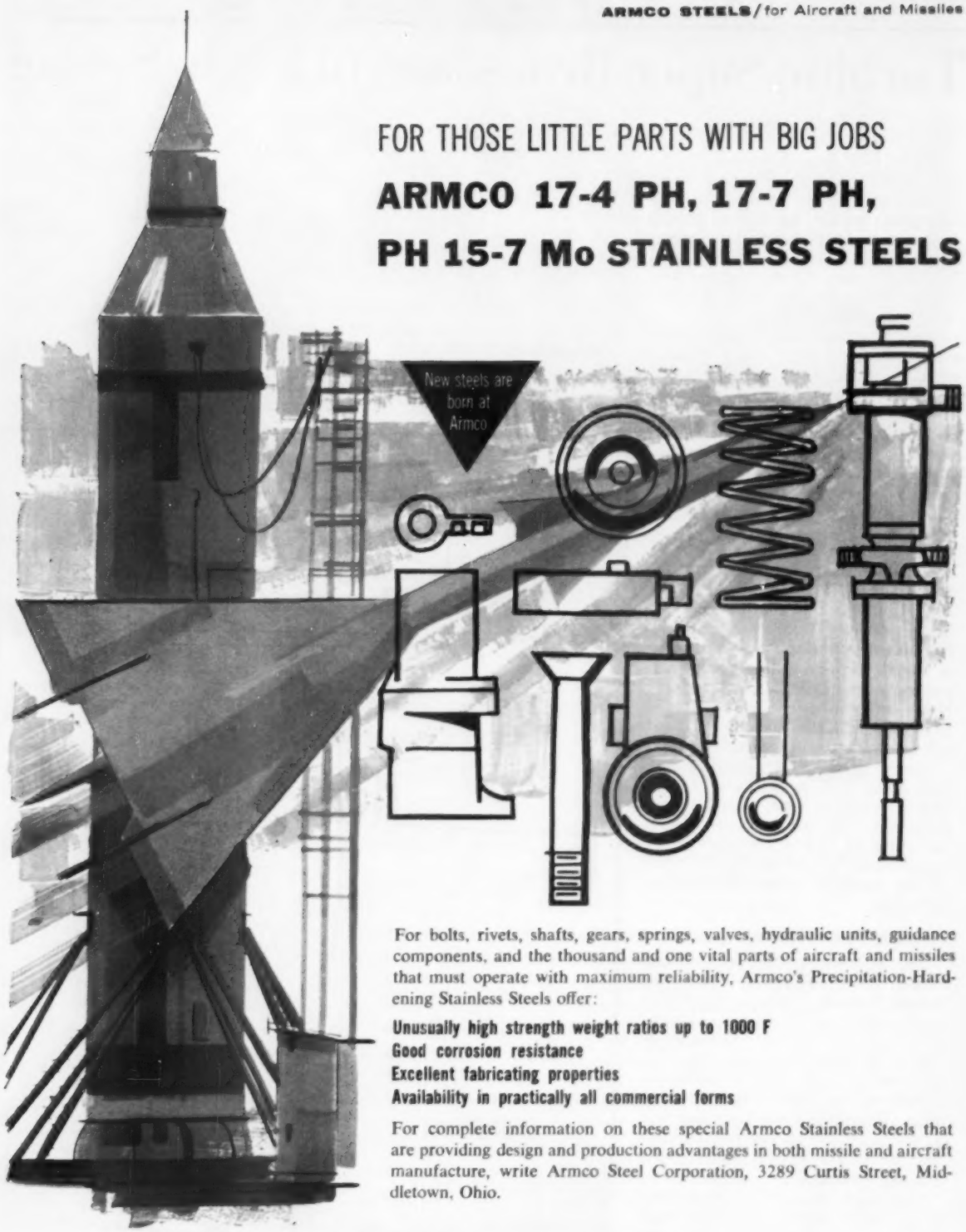

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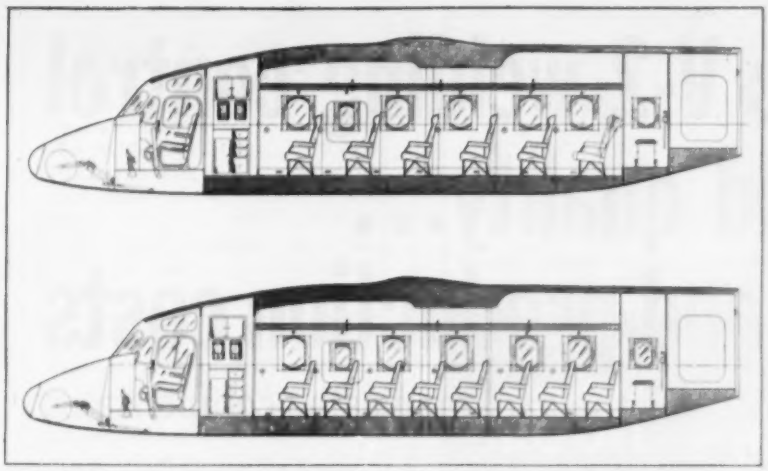


ALTERNATIVE seating plans for the MH-260 include a de luxe 17-seat version and a 23-seat configuration (bottom). Drawings show galley (forward) and lavatory (aft).

ditional emergency exit is provided in the fuselage overhead to provide egress in the event of a water ditching.

Access to the passenger cabin is via a door at the rear left side of the fuselage. The door is in two sections, the rear section opening sideways for passenger entrance and the forward section opening upward to admit bulky cargo.

Air conditioning for the cabin is by means of individual fresh air ventilators and 15 floor-level hot air vents. Soundproofing is achieved with removable vinyl-covered glass wool panels.

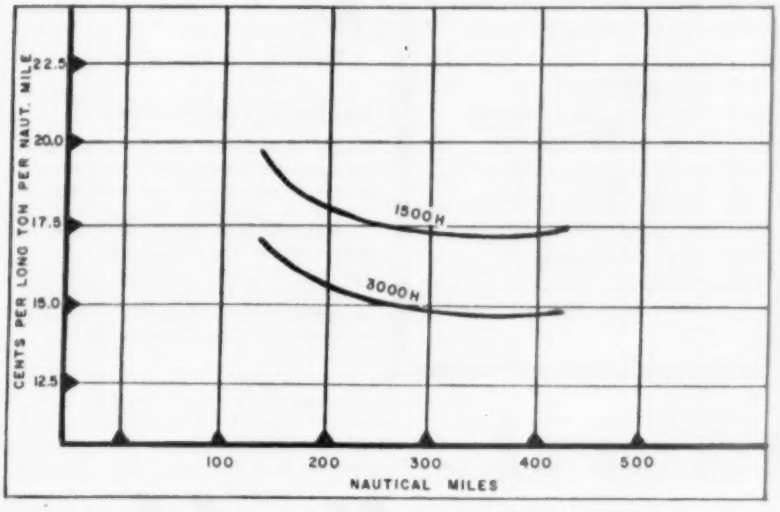
Immediately aft of the passenger cabin is a lavatory and to the left of this, at the cabin entrance, is a clothing wardrobe.

The baggage hold is the aftermost compartment in the aircraft. The 109.7-cu.-ft. hold is accessible through a door on the right side measuring 2.3 x 3.6 ft. The hold is lighted, vented and protected from fire by four fire detectors and an extinguisher actuated by the pilot upon receipt of a warning light indication. Maximum allowable weight in the baggage hold is 507 lb.

Landing Gear

The main gear of the Super Broussard retracts into wheel wells built into the fuselage sides. This configuration, while eliminating a long wheel strut extending from the engine nacelle, causes a rather narrow track (9.84 ft.) on the relatively small MH-260. This would appear to limit the aircraft's performance on rough fields and on crosswind landings; however, the company maintains that the torsion bar suspended landing gear has proved highly successful on the MH-250 prototype.

The wing of the aircraft is trapezoidal



MH-260 SUPER BROUSSARD operational costs are indicated in long tons per nautical mile for 1,500 and 3,000 hr. annual operation.

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Monautronic V-2 welding control certifies weld quality... cuts rejects and production costs

A resistance welding control that automatically compensates for every process variable

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The Monautronic V-2 compensates for undesirable variations usually encountered in resistance welding by maintaining voltage across a weld at a constant value. This constraint of voltage amounts to constraint of final weld temperatures, and such temperature control assures production of quality welds.

- **Automatic lockout**—occurs when process variations are so severe that the available current range would not cover the requirements for quality welding. The control detects extreme contamination, failure in the force system, overwelding, poor matching or fitup, and any other conditions that would result in substandard welds.
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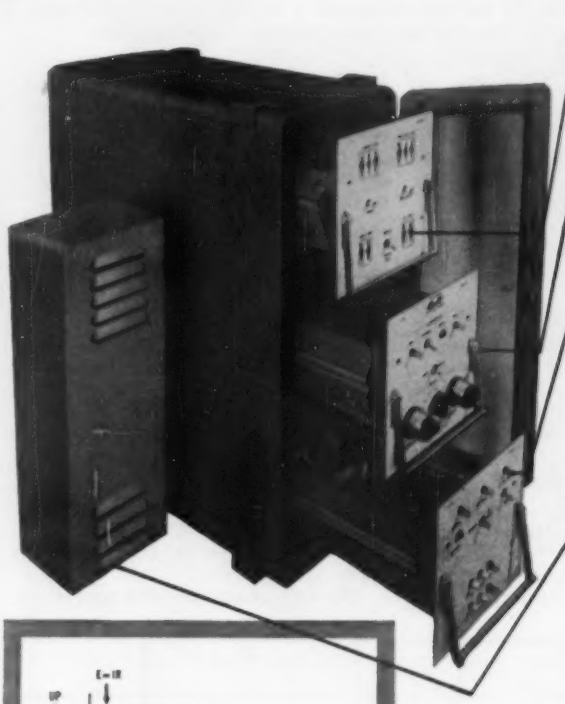
SEQUENCE MODULE—Utilizes digital pulse-type circuitry . . . provides 100% accuracy.
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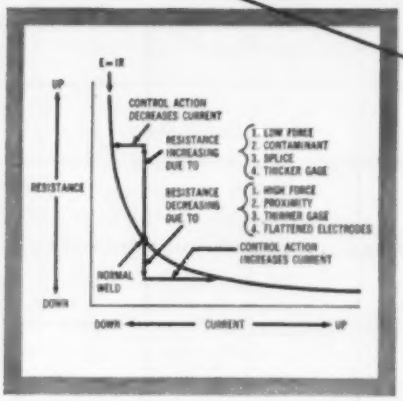


VOLTAGE CONSTRAINT

Graph shows how voltage control compensates for process variations. Any point on curved line E = IR represents a specific voltage. With normal weld as reference point, certain process variations cause increased resistance, while others cause a decrease. Control action is achieved through change of current to constrain voltage to same level for every weld.

for complete details contact: THE BUDD COMPANY
Electronic Controls Section • Philadelphia 32, Pa.

ELECTRONIC Budd CONTROLS

MH-260 Specifications

Length	58.1 ft.
Wing span	71.7 ft.
Wing root chord	10.2 ft.
Wing tip chord	5.9 ft.
Wing area	592 sq. ft.
Aspect ratio	8.8
Height	20.9 ft.
Takeoff weight (maximum)	21,165 lb.
Landing gear track	9.8 ft.
Wheel base	18.0 ft.

in planform with an 8.8 aspect ratio. The flaps are in two sections with a common central support. Ailerons are fabric covered.

Design maximum takeoff weight of the Super Broussard is 21,165 lb. (I. S. A. conditions). Takeoff under I. S. A. 20C conditions is 18,520 lb. Empty weight of the aircraft is 10,500 lb. This empty weight figure will vary slightly with the engine selected for the aircraft.

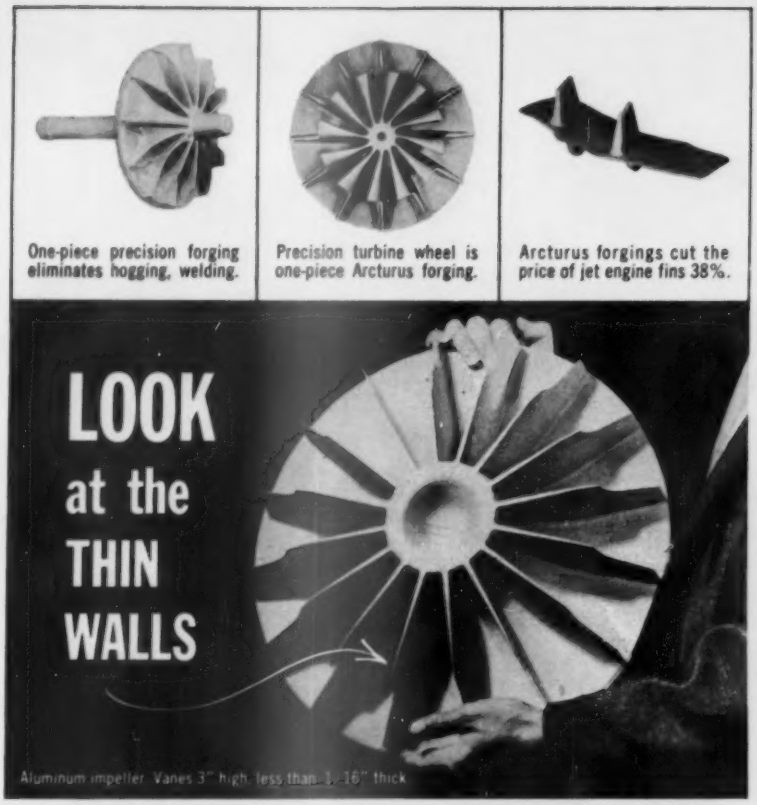
Maximum fuel capacity of the MH-260 is 3,307 lb. (475.6 gal.) carried in six wing tanks. Fuel consumption of the aircraft is listed at 130 gpm. at 9,840 ft. altitude at 205 kt. cruise. The company recommends a cruising altitude of 4,920 ft. at a lower speed for stage lengths of less than 155 mi. Fuel consumption of 145 gpm. at the lower altitude is gained back by the shorter climb period. Optimum performance of the Super Broussard at a weight of 18,078 lb. and a power level of 957 bhp. is said to be: rate of climb (sea level) two engines, 1,673 fpm.; single engine, 433 fpm. Cruise speed (sea level) 205 kt. at 740 bhp., 189 kt. at 592 bhp. Stall speed for the aircraft is given as 75 kt. no flaps and 48 kt. with full flaps.

Landing distance over a 50 ft. obstacle is 1,279 ft. and takeoff clearing a 50 ft. obstacle (30 deg. flaps) is 1,197 ft.

Holste says that it is confident of meeting the predicted performance of the Super Broussard because of the manner in which the MH-250, piston engine prototype, met its design criteria.

Beech Briefs Distributors On Servicing 1960 Planes

Customer service for 1960 line of Beech business planes will be the prime topic at joint councils conducted by the manufacturer for service and parts managers of the distributor organization in five regional locations this month. Meetings are being held in Philadelphia, Pa.; Davenport, Iowa; Oklahoma City, Okla.; Albuquerque, N. M., and Memphis, Tenn.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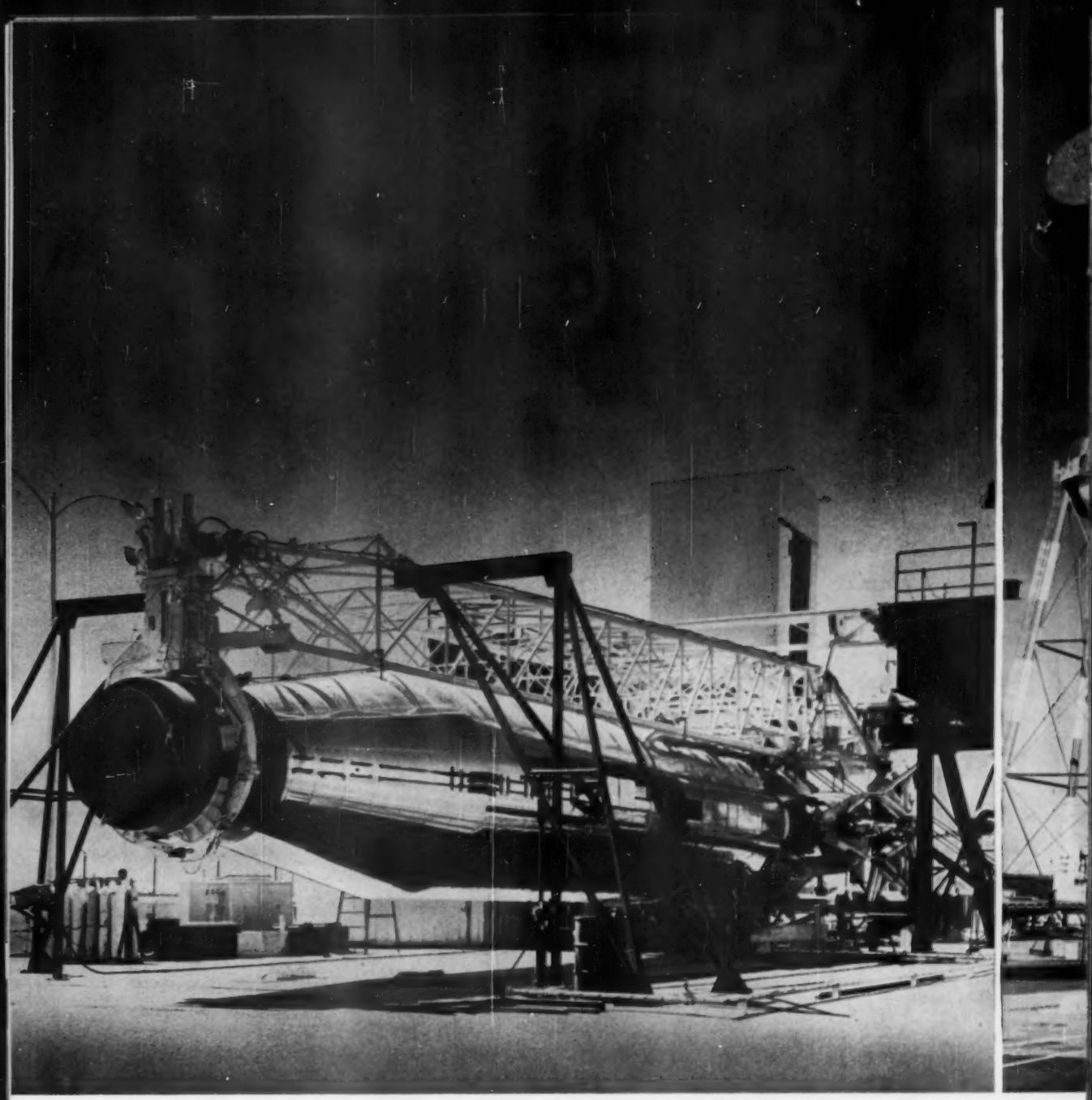

Westinghouse ATLAS erector control

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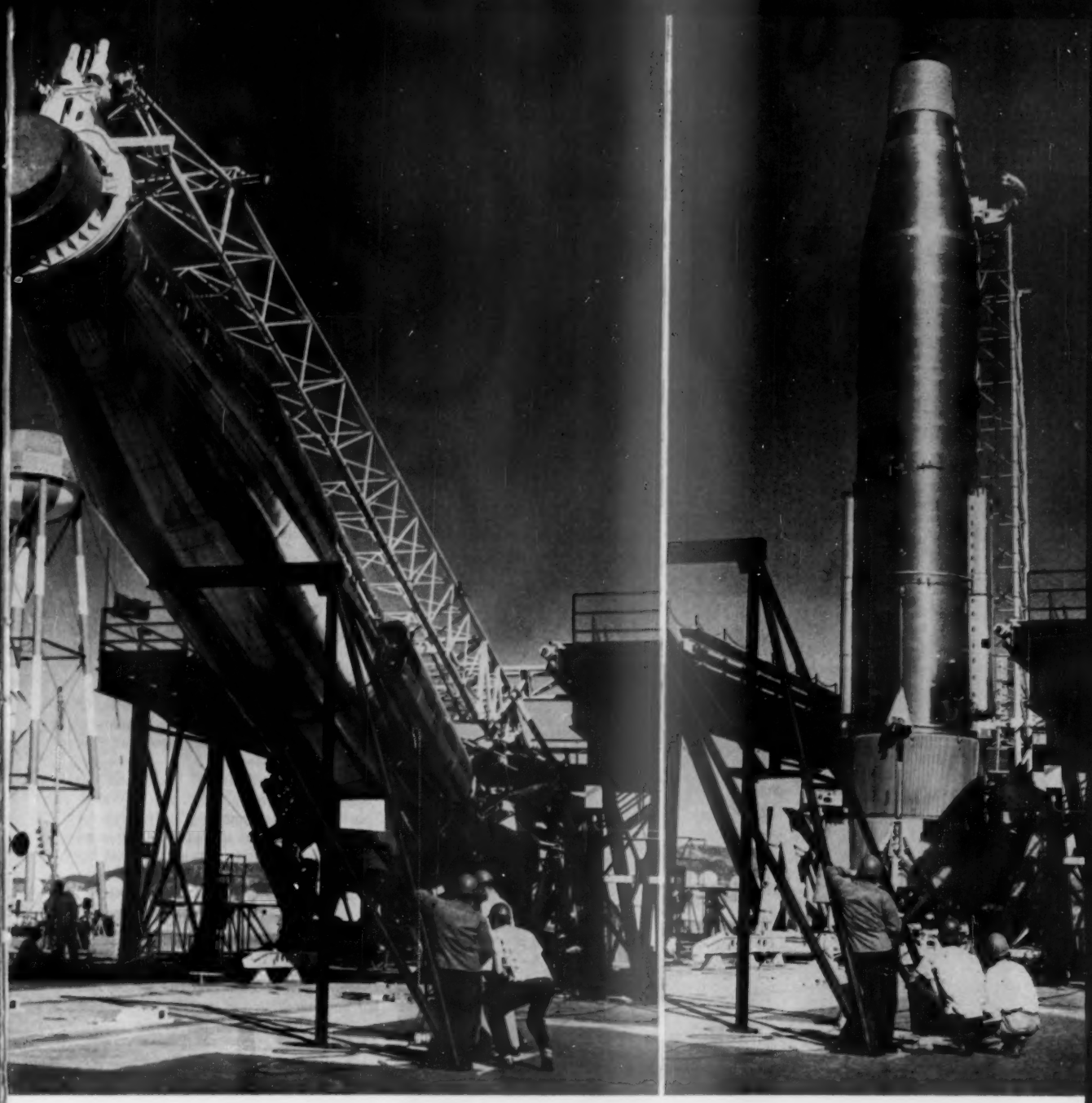
The Westinghouse React-O-Verse control system automatically raises the missile to its vertical firing position, checks to make sure that the missile is firmly seated on the launching pad, retracts and rotates the nose clamp and moves the erector boom out of the way—all without flexing or straining the bird at any point in the arc. A very complex and demanding job for electromechanical control.

This precision control, which compensates automatically for varying loads or wind pressures from any direction, is achieved with an exclusive Westinghouse system combining maximum reliability with watch-like accuracy. Static controllers, saturable reactors and Cypak® (miniaturized magamp) units program, check position and release, or, at any malfunction, return the missile to its horizontal position. No moving parts are present to corrode, wear



system assures handling reliability

out, require maintenance or fail at a vital instant.

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**The new ATLAS erector system is supplied by Goodyear Aircraft Corporation, Arizona Division, Litchfield Park, Arizona, under contract to Convair Astronautics Division, San Diego, California, prime contractor to USAF for ATLAS.*

J-92039

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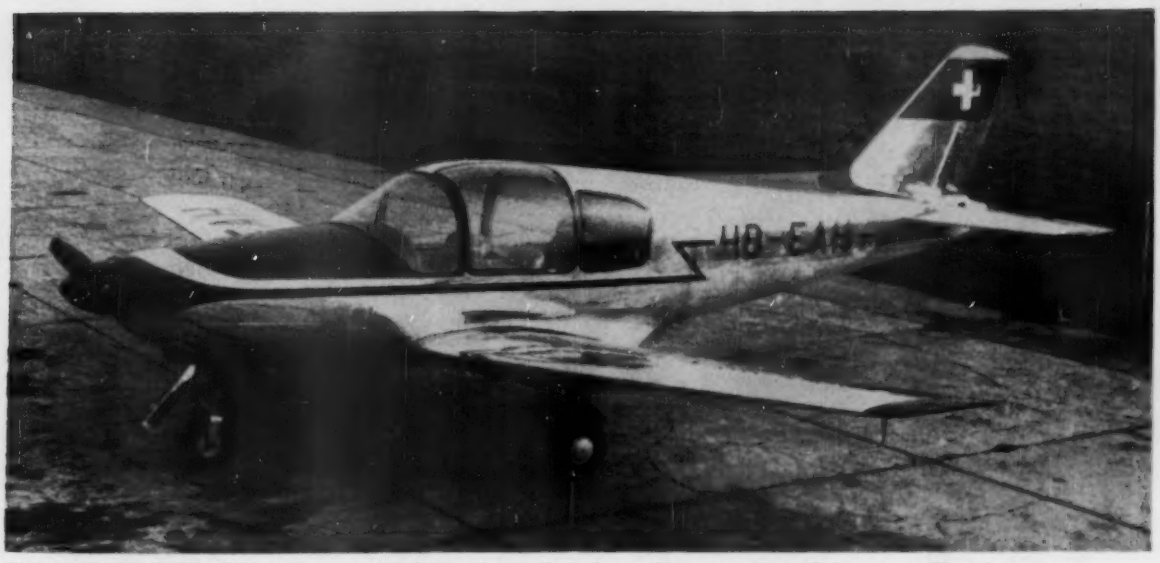


FIRST prototype Picchio F.15 three-seater was delivered to a Swiss buyer; four-seat version will have same dimensions.

Aviation Week Pilot Report:

Picchio F.15 Has Good Control Response

FINISHED wing sections (NASA laminar flow airfoils) are stacked up at the Procaer factory at Milan, Italy. Wing is one-piece and is bolted to the Picchio F.15 fuselage.

By Vico Rosaspina*

Milan, Italy—Procaer's Picchio F. 15 business and sport plane is a responsive aircraft with a cruising speed in the 160-mph. class.

Certificated under U. S. Civil Air Regulation Part 3, the Picchio "Woodpecker" can be flown as a fully-aerobatic three-seater in the utility category or as a four-seater under normal category requirements.

Major design feature of the Picchio is its combination metal and wood external skin, a laminate of birch plywood covered with a thin layer of aluminum alloy. This was chosen by designer Stelio Frati to combine the advantages of both wooden and metal construction.

Wood Uses

For the smaller aircraft factories of Europe, wooden aircraft construction is a natural, and in the field, maintenance and repair techniques are well-known. But all-metal skin is more weatherproof and can take the minor beatings from an unimproved field better than wooden structure.

The combination of metal skin on plywood base has given the Picchio a smooth external surface, which contributes to obtaining high aerodynamic efficiency from the NACA laminar flow airfoil.

* *Vico Rosaspina, former member of the Italian air force, is a freelance test pilot who has flown most of the types of aircraft used by the IAF. He has competed in many shows, winning the Grand Prix of Marseille.*

Characteristics of the three-seater Picchio prototype were described in AVIATION WEEK last July 13, (p. 119). Current production Picchios are all four-seaters, and the powerplant is a single Lycoming 0-360-A1A engine rated at 180 hp. at sea level and driving a two-bladed Hartzell all-metal constant-speed propeller. Fuel grade is 91/96 octane. Prototype engine was a Lycoming 0-320B, developing 160 hp.

Fuselage is monocoque structure in two sections bolted together. Both wing and fuselage are covered with plywood of about one millimeter thickness to which has been bonded an aluminum skin of about one-third that thickness. Construction is conventional for wooden aircraft.

Wing is one-piece, bolted to the fuselage. Section is an NACA 640 series with 15% root chord thickness ratio tapering uniformly to 9½% at the tip. Ailerons and flaps are constructed and skinned in the same way as the wing.

Landing Gear

Landing gear is tricycle and retractable, electrically operated. Mechanical system provides standby operation for emergencies. Nosewheel is fitted with a 5.00x5 low-pressure tire; main wheels have hydraulic brakes operated by an additional pedal on the rudder pedals. Main wheel tires are 6.00x6 low-pressure type.

Nosewheel is completely steerable on the ground, connected to the rudder pedals. This connection is interrupted automatically when the wheels retract.

Fuel is in two wing tanks and a single fuselage tank behind the firewall. Total capacity is just over 50 gal. which gives five hours' endurance.

Electrical system draws on a 24-v. battery and a 28-v., 15-amp. engine-driven generator. System consists of seven basic circuits: engine starter, landing gear, fuel contents gage, flying lights, panel lights, radio and optional gyro instruments.

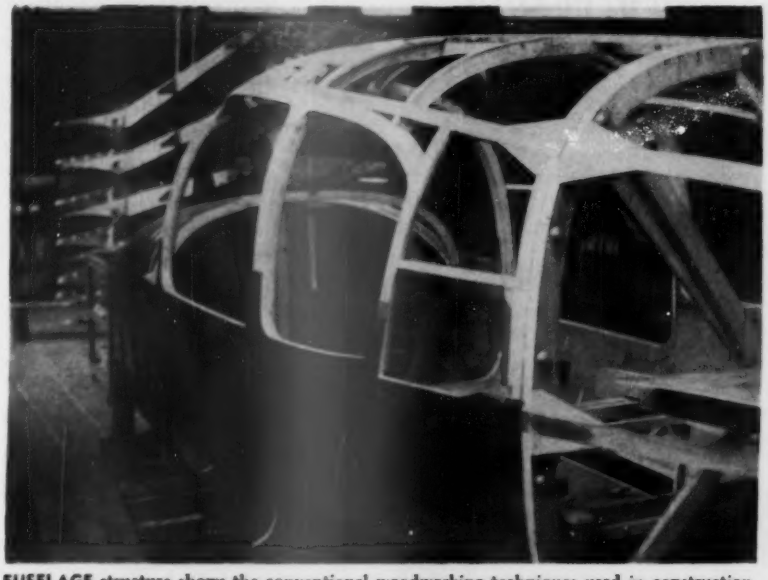
Cockpit Layout

Entry to the cabin is through doors which are hinged along the tops to the fuselage, and which swing high and wide to give easy entrance. Internal layout of the cockpit is reminiscent of American business aircraft in instrument placement, seating and decor.

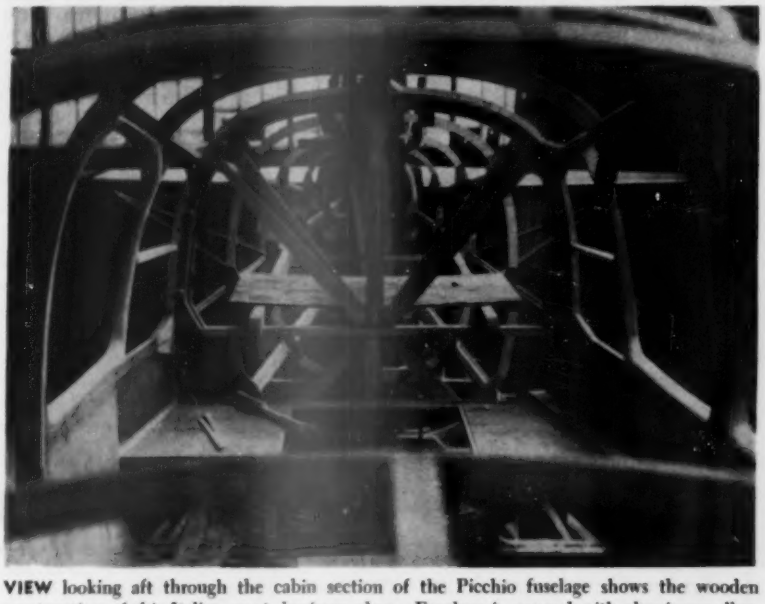
Complete dual controls are fitted; both pilots' seats are independently adjustable. Rear seat is a bench type, and there is plenty of leg and head room for tall passengers.

Seating is comfortable and visibility from the pilots' positions is excellent. Controls are easily accessible and full throws do not interfere with the pilot's body. All auxiliary switches or controls are well-located, separated from

COCKPIT layout of Picchio F.15 is uncluttered, and panel is standard with optional instrument flying group and the possibility of installing additional radio equipment.



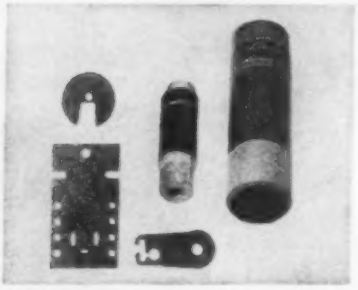
FUSELAGE structure shows the conventional woodworking techniques used in construction. The fuselage is built in two major sections, bolted together at bulkhead at right above.



VIEW looking aft through the cabin section of the Picchio fuselage shows the wooden construction of this Italian sport, business plane. Fuselage is covered with aluminum alloy.

PROGRESS IN PLASTICS

HIGH-TEMPERATURE STRUCTURAL PARTS FOR MISSILES FROM NEW DILECTO® LAMINATES



Fabricated parts made from new CDF Dilecto® high-temperature-resistant laminate, grade AAA-HR.

A new CDF laminate, Dilecto AAA-HR, can be used in short-time ablative applications in rockets at temperatures of 5,000°F, and in continuous industrial service at temperatures approaching 500°F.

The new CDF Dilecto laminate demonstrates an ablation rate of from 0.0052″ to 0.0072″ per second by gases at 4,700°F and Mach 2.5. This rating makes Dilecto AAA-HR suitable for parts in direct contact with burning rocket propellants.

Negligible change in dimensions and mechanical properties has been noted in finished parts subjected to temperatures of 300 to 350°F in dry or wet heat. Other tests show that these laminates retain their mechanical properties after 2-hour immersion in boiling water or 30-day immersion at room temperature.

Made from extra-long-staple nonferrous crude asbestos fiber, impregnated with a high-temperature-resistant phenolic resin, these new Dilecto laminates are recommended for applications requiring continuous exposure to temperatures up to 500°F, intermittent service up to 900°F, and for short-time exposure to 5,000° F. The laminates may be machined by conventional techniques. Parts molded from CDF Celoron® 22HR and Celoron 26HR are used where a molding rather than a machined part is desired. Celoron 26HR is used in missiles, and Celoron 22HR is intended for industrial use.

REUSABLE AIRCRAFT-INSTRUMENT SHIPPING CASES

Designed for safe transport of radio receivers, transmitters, radar equipment, and other delicate aircraft instruments between field stations and overhaul points, new CDF lightweight containers are manufactured to ATA Packaging Committee specifications.

They're made from 100% CDF Diamond® Vulcanized Fibre, riveted and reinforced with steel corners and other hardware. The inside is completely padded with a 1¼ to 2″ thickness of canvas-covered polyurethane foam, for maximum protection of the instrument within. Flush-fitting metal handles facilitate plane-loading and prevent damage to other luggage.

CDF shipping cases are made in ATR (Air Transport Rack) sizes ¼, ⅜, and ½. Other sizes available on special order.

CDF Fibre instrument shipping case opened to show polyurethane foam cushioning.

NEW CDF LITERATURE

Information on new grades, special applications, and outstanding properties of CDF insulating materials is made available regularly through CDF technical bulletins and brochures.

The following literature is new. For copies of any of the bulletins listed, check the appropriate squares on the coupon.

Epoxy Laminates—Bulletin 11,200
Di-Clad Laminates—Bulletin 11,900
Paper-Base Laminates—Bulletin 11,110
Celoron Molded Products—Folder C-59
Glass-Supported Teflon—Folder GST-55A
Polyester-Glass Laminates—Folder PD-59

CONTINENTAL-DIAMOND FIBRE
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Please send me the following CDF literature:

- ☐ Bulletin 92—High-temperature-resistant asbestos-phenolic laminates
- ☐ Bulletin MHC-591—CDF Fibre instrument-shipping cases
- ☐ Others (specify)_____

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CONTINENTAL-DIAMOND FIBRE
A SUBSIDIARY OF THE Budd COMPANY • NEWARK 19, DEL.
In Canada: 46 Hollinger Road, Toronto 16, Ontario

Picchio F.15

Dimensions and Weights

Wingspan	30.5 ft.
Over-all length	23.9 ft.
Over-all height	9.2 ft.
Wing area	130.4 sq. ft.
Empty weight	1,430 lb.
Useful load	880 lb.
Gross weight	2,310 lb.

adjacent controls and easily reached by either pilot.

I flew the Picchio for this AVIATION WEEK pilot report in good weather at Linate Airport near Milan. Field elevation is about 200 ft.; outside air temperature was 15C (59F). There was no wind.

Visibility was excellent taxiing out. The Picchio steers easily with the rudder pedals at low groundspeeds. I lined up for takeoff, lowered the flaps 15 deg. and opened the throttle. Nosewheel came up at 42 mph., and the Picchio left the ground at 60 mph. With flaps and gear retracted, best climbout speed is 93 mph., and the corresponding rate of climb is a little over 1,000 fpm.

Speed Runs

We levelled off at 2,000 ft. for speed runs.

Maximum indicated speed at 2,700 engine rpm. was 184 mph. At 2,400 rpm., speed decreased to 166 indicated airspeed and at 2,300 rpm. we had reached 158 IAS.

Controls are responsive in all configurations. In all normal configurations and center of gravity positions, the aircraft can be trimmed and flown hands off. Ailerons are very effective.

CLOSEUP of Picchio midsection shows bolts which secure two basic fuselage sections made of wood.

hma

COMPLETE CAPABILITY

GSE

Now in quantity production, Horkey-Moore-designed Ammonia Servicing Trailers will help SAC's Hound Dog equipped B-52Gs guard the peace of the '60s. Designed to a new modular concept, pioneered by Wright Air Development Center and North American Aviation, GAM-77 ground support equipment like this HMA trailer lowers costs and improves airborne readiness. Here's another instance where Horkey-Moore engineering ability and production experience have been called upon for advanced, reliable ground support systems for aircraft and missiles.

hma

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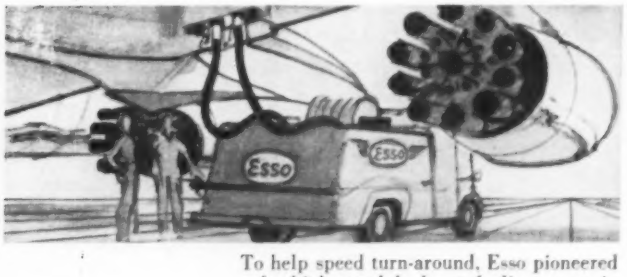
Pan American 707

Saving precious time for airlines:
HOW ESSO DOES IT!

All airlines see record expenditures in the jet age. Turn-around time is a major factor . . . extra minutes on the ground may mean lost revenue for airlines. Esso is helping to cut this costly ground time to the minimum by supplying the fuels, lubricants and *service* that will assure airlines bigger dividends from their investment in jet age equipment.



To help speed turn-around, Esso pioneered safe, high-speed hydrant fueling—now in use at many major airports worldwide. And Esso developed large-capacity mobile refuelers with extra-fast pumping rates.

Esso service crews everywhere benefit from Esso's Jet Age Training Program—most advanced and comprehensive in the industry. *Wherever* you see the Esso sign, you can depend on quick, careful and competent service.

INTERNATIONAL AVIATION PETROLEUM SERVICE

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Procaer Organization

Construction of the Picchio is being done by Progetti Construzioni Aeronautiche S. p. A.—Procaer for short—of Milan, a firm operated by Rico Neeff.

Stelio Frati, who designed the Picchio, is a professor of aeronautical engineering at the Polytechnic Institute in Milan. He and Neeff were students there, graduated together and formed a friendship that has now become professional collaboration.

Frati's Picchio design and his Cobra executive jet are being built exclusively by Procaer. Two earlier Frati designs—Falco and Nibbio—are in production at Aviamilano.

The Procaer factory is typical of smaller plants building wooden aircraft. Work staff numbers about 30; plant area is about 13,000 sq. ft.

All basic fabrication of the Picchio and later the Cobra is to be done at this factory, except for the bonding of the aluminum-plywood skin which is done by the plywood supplier.

Normal rate of roll in cruise configuration is about 85 deg. per second.

Minimum stalling speed with flaps and gear down is 53 mph. There is noticeable buffet before the stall and the stall itself is gentle. The Picchio does not fall off on a wing, but the nose drops straight ahead about 15 or 20 deg. Recovery is rapid, with an altitude loss of about 60 ft.

Limit speed with gear down is 124 mph.; flaps can be fully extended at 105 mph.

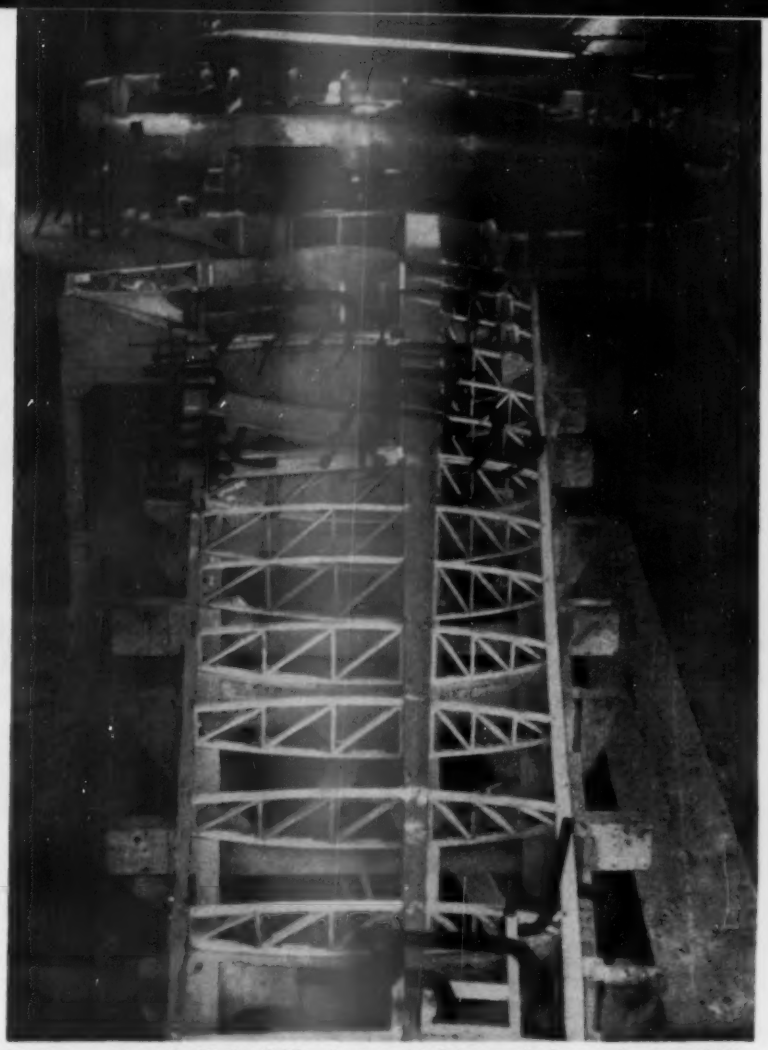
Approach Speed

Normal approach speed is about 80 mph., reducing to about 69 mph. coming over the fence and touching down nose-high at about 56 mph. Picchio can be completely stopped with normal braking in about 550 ft.

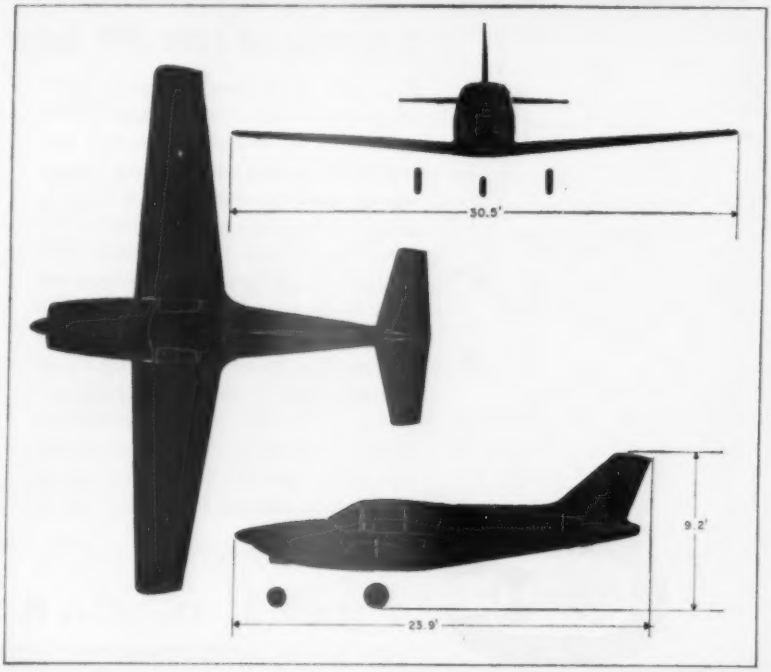
First prototype Picchio flew in June, 1959. Procaer, under the direction of Rico Neeff, has built and sold both prototypes, five preproduction airplanes and the first production batch of 10 aircraft. The company is planning a production run of 40 airplanes next, and license rights for construction are being negotiated in Australia and South America.

Annual operating costs of the Picchio have been calculated using American formulas but European cost figures for gasoline and oil. Considering depreciation to 20% residual value after five years, an average 500 flight hours per year and the services of a professional pilot, total operating costs are about $20 per hour.

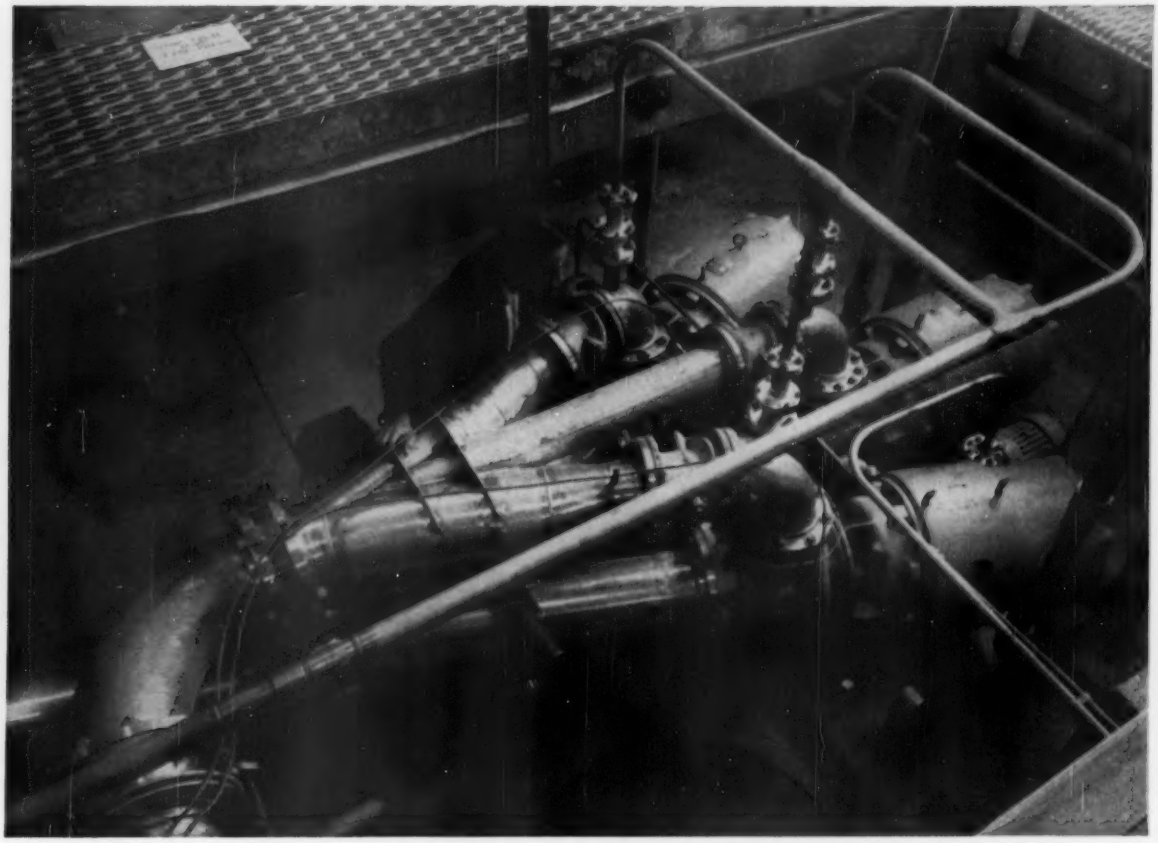
If a professional pilot is not required, costs drop to about $15.



FINAL assembly of the Picchio F.15 is done on this fixture at the Procaer factory in Milan. Wing tank space and gear well is at upper left. Below is Picchio three-view.



FIRST ICBM Liquid Oxygen Pump Loading System Successfully Tested at Edwards AFB



Carter Designed 6,000 GPM System Simplifies Propellant Loading

Developed on Air Force contract and independently tested by Convair Astronautics at Edwards Air Force Base, this first high flow liquid oxygen pump loading system was designed to replace present complex pressure loading systems. Quadrupling previous capacity limits, the new system incorporates a unique combination of single and multiple fixed speed pumps to accomplish the required control without complex low efficiency variable speed devices. The Carter system includes a control center incorporating high reliability standard components which automatically sequences system cool-down, rapid fill, fine fill, and topping functions in response to signals from the missile system. No human attention is required after the loading is started.

Unique fail safe feature assures continuous reliability. In case of any malfunction in either of the main pumps, Pump A automatically comes on the line at 1760 RPM to prevent aborting the mission.

The system consists of four separate pumps operating as follows:

Operation	Pumps On	Speed	Flow-Rate
Cool-down	A	870 RPM	Variable
Rapid Fill	B & C	1760 RPM	6000 GPM
Fine Fill	A	1170 RPM	700 GPM
Topping	D	3500 RPM	27 GPM

Write for further information or phone LIberty 8-3421

THE J. C. CARTER COMPANY

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Catalina Island Opened to Private Planes

By William S. Reed

Catalina Island, Calif.—Catalina Island Airport now is open to private aircraft up to Douglas DC-3 size providing they are properly licensed and equipped with two-way radios.

The airport, as well as the entire 76 sq. mi. island, is under the management of the Santa Catalina Island Co., an organization set up to operate the island for the William Wrigley estate.

Although the runway resembles a table top, or an outsized aircraft carrier, safe operation can be conducted here providing the few simple ground rules laid down by the company are followed. Airport Manager R. D. Sheker, recommends that the following procedures be used by private pilots:

- **File a flight plan** with the Federal Aviation Agency prior to departing the mainland. Although only about 22 mi. of open water separate Catalina from the mainland, it is advisable to have appropriate agencies alerted in case of emergency. Flight plans can be closed out by phone after landing or via radio while still airborne prior to landing.
- **Have sufficient altitude** to glide to either shore in the event of engine failure. Although this varies with each aircraft, this AVIATION WEEK pilot maintained about 7,000 ft. and decided that a water landing, if unavoidable, would be made next to one of the many ships plying the coast.
- **Ensure that radio** communication on Unicom, 122.8 mc., is established prior to approaching the airfield. This is because certain wind conditions produce tricky but not unpredictable currents on final approach.

Wild Buffalo

One additional reason for insisting on two-way radio communication on Unicom frequency is that an occasional wild buffalo may wander onto the runway.

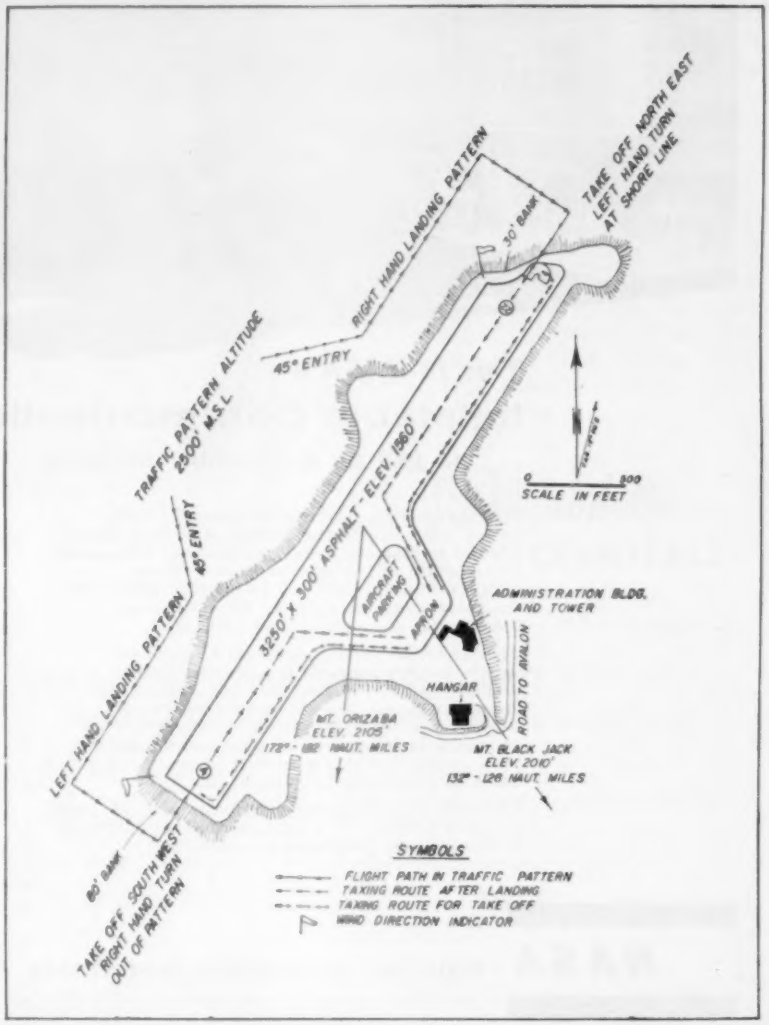
Natural coloring of the buffalo makes it blend almost perfectly with the texture of the runway, rendering it difficult to see by an approaching pilot. These rare occurrences are solved by herding the buffalo off the runway with a Jeep.

- **Maintain VFR flight rules** and operate during hours of daylight only.

The airport is not open to inexperienced or student pilots, Sheker says, because of the nature of the surrounding terrain, although what constitutes an "inexperienced pilot" was not defined.

Runway is 3,250 ft. long and 300 ft. wide and is at an elevation of 1,560 ft. From the air, the width of the strip in

CONSTRUCTION of Catalina Island Airport was started prior to World War II and completed in 1947. Field elevation is 1,560 ft. Runway length is 3,250 ft. x 300 ft.


TAKE OFF NORTH EAST LEFT HAND TURN AT SHORE LINE
30° BANK
RIGHT HAND LANDING PATTERN
45° ENTRY
TRAFFIC PATTERN ALTITUDE 2300' M.S.L.
45° ENTRY
LEFT HAND LANDING PATTERN
3250' X 300' ASPHALT - ELEV. 1560'
SCALE IN FEET
0
800
AIRCRAFT PARKING APRON
ADMINISTRATION BLDG. AND TOWER
HANGAR
ROAD TO AVALON
MT. ORIZABA ELEV. 2105' 172° - 102 NAUT. MILES
MT. BLACK JACK ELEV. 2010' 132° - 126 NAUT. MILES
80° BANK
TAKE OFF SOUTH WEST RIGHT HAND TURN OUT OF PATTERN
SYMBOLS
FLIGHT PATH IN TRAFFIC PATTERN
TAXING ROUTE AFTER LANDING
TAXING ROUTE FOR TAKE OFF
WIND DIRECTION INDICATOR

This is NASA's

Inflatable Communications Satellite

. . . as tall as a 10-story building

This shimmering sphere of aluminized plastic, merely one half of a thousandth of an inch thick, is 100 feet in diameter, yet it weighs only 150 pounds. The satellite will be several times brighter than the Pole star and will be plainly visible with the naked eye while orbiting the earth every 118 minutes at an altitude of 1,000 miles.

The NASA inflatable satellite is a significant step in the development of advanced global communications. The satellite will reflect radio and radar signals from powerful earth-bound transmitters for investigation of forward scattering techniques of communications and propagation. NASA has invited scientists around the world to participate in this project.

This endeavor—only one of many now in advanced stages of fruition . . . is indicative of the calibre of NASA projects, personnel and resources.

If you are a scientist or engineer and would like to become associated with NASA, address your inquiry to the Personnel Director of any of the following NASA research centers:

Langley Research Center,
Hampton, Va.

Ames Research Center,
Mountain View, Calif.

Lewis Research Center,
Cleveland 35, Ohio

Flight Research Center,
Edwards, Calif.

Goddard Space Flight Center,
Washington 25, D. C.

NASA National Aeronautics and Space Administration

relation to its length gives the impression that it is shorter than it actually is. Another factor becomes apparent when flaring out for a landing: the runway is slightly sloped, having a positive gradient of 1.7 to the southwest. Therefore, the management recommends landing on Runway 22 even with a 10 kt. tailwind.

Similarly, takeoffs on Runway 4 are facilitated by the downhill run.

Traffic patterns are always made with the downwind leg on the northwest side of the runway to avoid mountains to the southeast. Therefore, landings on Runway 22 are from a righthand pattern, lefthand on Runway 4. Pattern altitude is 2,500 ft. mean sea level, slightly higher than the highest point on the island which is 2,125 ft.

Navigation Aids

Catalina Airport also has an omnirange (114.4 mc. SXC) transmitter located atop Mt. Orizaba, 1.8 naut. mi. from the center of the runway. The range station has no voice facilities and was installed for the purpose of providing a fix for IFR traffic in the Los Angeles area. Also available as a homing facility is radio station KBIG, broadcasting on 740 kc. at a power of 50,000 watts. KBIG features a daily aviation weather report at 8:30 a.m.

At the airport, a Spanish-type stucco building serves as passenger terminal and administration building. United Air Lines at one time served the island on a scheduled basis but discontinued service when its DC3s were replaced. The airport was determined to be unsuitable for Convair operations. Pacific Airlines also served the island but has not received a renewal of its franchise which expired. During the summer tourist season, Catalina Pacific Airlines operates passenger flights to the airport.

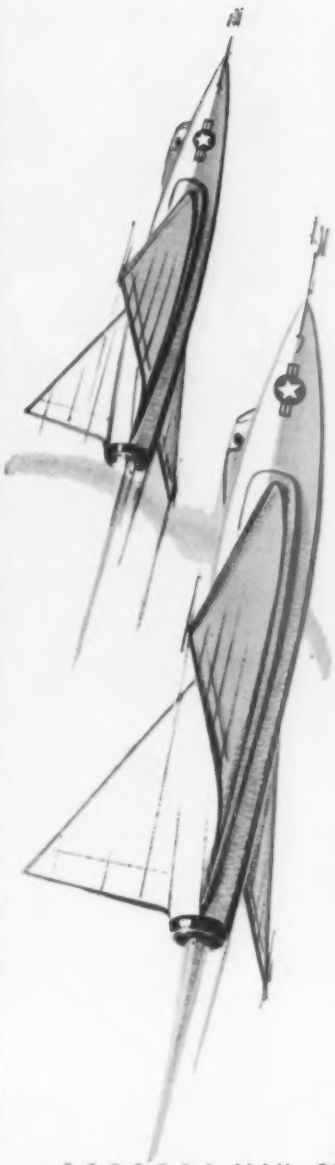
Seaplane Bases

Seaplane facilities are located in Avalon Harbor where passengers are boarded at a pier and at a seaplane slip about one mile south along the coast. Seaplanes are operated by Avalon Air Transport and consist of a Grumman Goose, operating year-around, and a four-engined Sikorsky S-41 flying boat operating during the summer tourist season. Round trip seaplane fare from Los Angeles is $15.90; from Long Beach, $13.70. Many visitors to the island prefer seaplane service which debarks them directly in Avalon. Land plane trips must be completed by the 30-min. ride from the airport. Transportation by boat takes about 2½ hr.

Sheker, who has been executive pilot for the Wrigley estate for more than 10 years operating a Douglas DC-3 and a Grumman Widgeon, predicts a modest but steady increase in private aircraft movements at the island airport.

Jet-age "spit-and-polish" starts with . . .

AEROWASH-A



. . . Wyandotte's multi-purpose aircraft cleaner for all exterior surfaces . . . even jet exhaust stains

Those sleek, gleaming, glamorous jets pose some pretty tough cleaning problems. AEROWASH-A is equal to the toughest of them . . . actually removes jet-engine exhaust stains with very little hand labor!

This in itself is quite remarkable . . . but even more so is the fact that, despite its cleaning effectiveness on all common metals, AEROWASH-A will not damage interior surfaces. It is safe to use on plastics, fabrics, or rubber. It is non-toxic, mild on skin, and nonflammable when diluted with water or used straight. And it is Air Force approved!

For full details on AEROWASH-A, and other aircraft-cleaning products, call your Wyandotte representative. Or mail the coupon below. *Wyandotte Chemicals Corporation, Wyandotte, Michigan. Also Los Nietos, California, and Atlanta, Georgia. Offices in principal cities.*

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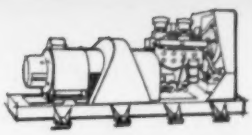
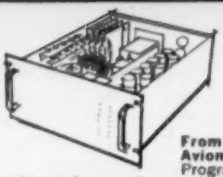
Move a Ramp... Start a Jet...

CONDEC Products for Aircraft and Missiles



From Power Equipment Division . . . The world's only completely Uninterrupted Power Supply System. It continues to carry full electrical load with absolutely no outage when prime source fails, provides vital power protection for radar, critical communications and ground-support activities.



From Consolidated Avionics . . . a New Programmable DC Signal Source. It accepts digital input signals and instantaneously presents selected output voltage. Automatic check-out equipment for such projects as Jupiter, Atlas, Titan and Discoverer projects are also products of Avionics.

F-104 Servicing Unit . . . uses a gas turbine engine to supply starting air for jet engines, and provides electrical power, high pressure air, and towing — everything needed to keep this aircraft combat ready, any place in the world. (USAF designation; MA-2 Multi-Purpose Servicing Unit).

Launch a Missile / CONDEC

This new Condec Passenger Loading Stand offers new economy and turn-around efficiency for United Air Lines' new DC-8's. It has been specially engineered and built to provide a number of unique and exclusive features, including built-in propulsion, elevation, illumination and stabilization, plus an upper platform control station.

A revolutionary, self-propelled passenger ramp to service America's newest jet airliner is the latest in a long line of products and problem-solving developments for aircraft and missile support produced by the Aircraft Equipment Division of Consolidated Diesel Electric Corporation.

The Aircraft Equipment Division is also responsible for many other new concepts in ground support equipment . . .

Gas turbine engines have been designed into mobile units to supply starting air for aviation jet engines.

Condec "packaged" servicing units furnish electrical, pneumatic and hydraulic power, plus conditioned air for heating and cooling, for supporting jet fighters, bombers and transports.

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This is Condec. Call on the Aircraft Equipment Division for these and most other equipment required throughout the ground support functions; or call on CONDEC'S AED to provide systems management and full responsibility — from concept to delivery — of sub-systems for the support of land, sea, air and space weapons and vehicles. A facilities and product brochure has been prepared to tell you in detail about the CONDEC story. Send for it today.

From Consolidated Controls . . . a complete line of ruggedized pressure switches — from inches of water to hundreds of atmospheres — for high performance aircraft and missiles. Includes a new high temperature (to 1000F) model.

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ENGINEERING
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VERSATILITY PLUS—IN GROUND ANTENNA PEDESTALS

This Bendix Ground Antenna Pedestal is unique in that it can be easily modified to a variety of radar antenna applications, some of which are shown above. In addition, the pedestal is *air transportable*—weighing only 700 lbs.; *accurate*—better than 0.5 mils; *available*—already designed, tooled and available for your immediate prototype needs—the product of our extensive field and test experience in building for highly accurate tracking of aircraft and missiles.

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For further information about this unit—and others in the Eclipse-Pioneer "family" of radar antenna devices—write:

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Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

Poland May Expand Foreign Glider Sales

Moscow—Poland is continuing to strengthen its position as the Communist bloc's leading glider designer, builder and exporter.

The Soviet satellite has recently shipped gliders and equipment to the Soviet Union, Communist China, East Germany, Hungary, Austria, The Netherlands, Switzerland, Belgium, England, India and Finland. It confidently expects further expansion of foreign sales.

Center of design and development work is the experimental glider factory at Bielsk. Headed by Vladislav Novakovsky, the plant builds experimental models and limited numbers of high-performance gliders. Quantity production is assigned to other Polish glider factories.

Among the Polish gliders now in quantity production and being exported in considerable numbers are the single-place Jaskolka (Swallow), which has set five world records (AW Nov. 16, p. 83); the single-place Mucha-100A (Fly) and Mucha-Standard; and the two-place Bocian (Stork) and Czapla (Heron).

Gliders of "original design" being produced in "experimental copies" or in small numbers include two flying wing types—the Nietoperz (Bat) and Wampir (Vampire); the Kaczka (Duck); the Sroka (Magpie) trainer; the Jastrzab (Hawk) acrobatic glider; the Osa (Wasp) and Seagull laminar gliders; and the record-setting Albatross, Motyl (Butterfly), Zefir (Zephyr) and Foka (Seal).

Cessna Unit Sales Rose 22% in 1959

Wichita, Kan.—Final figures on Calendar 1959 business plane production show that Cessna sales totaled 3,564 units, 84 airplanes more than the combined sales of the other three top manufacturers, according to Frank Martin, Cessna marketing manager.

With the entire business aircraft industry enjoying an approximate 20% increase in sales in 1959, Cessna showed a gain of 22% over Calendar 1958, for an increase of 638 airplanes, Martin noted, adding that he looks forward to the company enjoying another record year in 1960.

Breakdown in unit sales by the company during 1959 shows: 648 Model 150s, 874 Model 172s, 727 Model 175s and Skylarks, 258 Model 180s, 774 Model 182s and Skylanes, 43 Model 210s and 240 twin-engine Model 310s. Both Skylark and Model 210 were introduced to the public late last year.

Fletcher Ships FU-24 Kits to New Zealand

Fletcher Aviation Corp., El Monte, Calif., has shipped three FU-24 spray planes to Air Parts, Ltd., Rukuhia Airport, Hamilton, New Zealand, in prefabricated kits. Kits utilize "matched hole tooling" concept which allows local labor to assemble the planes with hand tools; more than 60 FU-24s have been assembled this way in New Zealand. FU-24 is powered by a 240 hp. 0470-N Continental engine, is 31 ft. 10 in. long, 9 ft. 4 in. high and has a 42 ft. wingspan. Empty weight is 1,890 lb. and useful load is 1,610 lb. Cockpit "safety zone" is stressed for 40g loads.

Cessna started holding the first of four marketing conferences to introduce the new Model 310D—latest, swept-tail version (AW, Dec. 28, p. 24)—early in January, with additional meetings scheduled for the remainder of the month. Sessions with distributors, dealers and their salesmen will include comparison demonstrations of the new 310D with competitive types at the Wichita factory.

47G-2 Airlifts Steel For Helistop Site

Los Angeles—McNeil Construction Co. is using a Bell 47G-2 Trooper helicopter in building a helicopter landing pad atop the Pacific Electric building in the downtown area here.

The helicopter airlifted 16 checkered steel plates from a bus deck just above

U. S. Business & Utility Aircraft Shipments

October, 1959

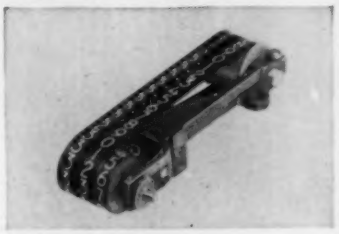
Manufacturer and Model	No. of Units	Net Billings
Aero Design 500	7	$995,000
500E	4	
680E	4	
Beech 185	2	$1,479,000
Bonanza	14	
Twin-Bonanza	5	
Travel Air	12	
Callair A9	1	$9,000
Cessna 150	55	$4,174,000
172	288	
175	20	
180	12	
182	21	
310	15	
Champion 7EC	1	$125,000
7FC	3	
7GC	9	
7HC	8	
Mooney Mk. 20	10	$115,000
Piper PA-18	14	$2,203,920
PA-18-A Super Cub	6	
PA-22 Tri-Pacer	75	
PA-23 Apache	16	
PA-24 Comanche 180	29	
PA-24 Comanche 250	24	
PA-25 Pawnee	22	
Totals	681	$9,100,920

Note: Considerable increase in number of units shipped in October compared with previous month, when 385 aircraft having total net billing value of more than $7.9 million were delivered from the factories, reflects stepped-up delivery pace as new models come off the lines. October, 1959, shipments also are considerably larger than the same month last year when 589 aircraft left the factories with a total net billing value of more than $7.7 million. Shipments January through October, 1959, totaled 6,296 units valued at $106,633,000. This represents 982 more aircraft and $22,536,000 higher total value than for the same period in 1958 when 5,314 aircraft valued at $84,097,000 were delivered to distributors and dealers.

ENGINEERING REPORT ON OTHER BENDIX COMPONENT PACKAGES

AZIMUTH COUNTER

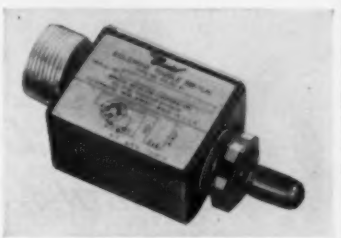
Presents angular information in 1° increments.



These lightweight digital display counters, featuring stainless steel types, are readily adaptable to fire control devices, aircraft and industrial instrumentation uses. Counter wheel numerals are $\frac{1}{4}$" high. They count in increments of 1° from 000° to 359° and repeat, with a cycle of operation infinitely repeatable and reversible. Available with either left-hand or right-hand input shafts. Request details.

SOLENOID TOGGLE SWITCH

Corrosion-resistant unit for severe operating conditions.



Developed for the severe environmental conditions outlined in MIL-E-5272A, this small, lightweight unit consists of a miniature micro-switch actuated by a toggle held in place by a solenoid-operated detent. In case of circuitry failure, the manually-operated toggle switch is returned to normal position automatically. Write for details.

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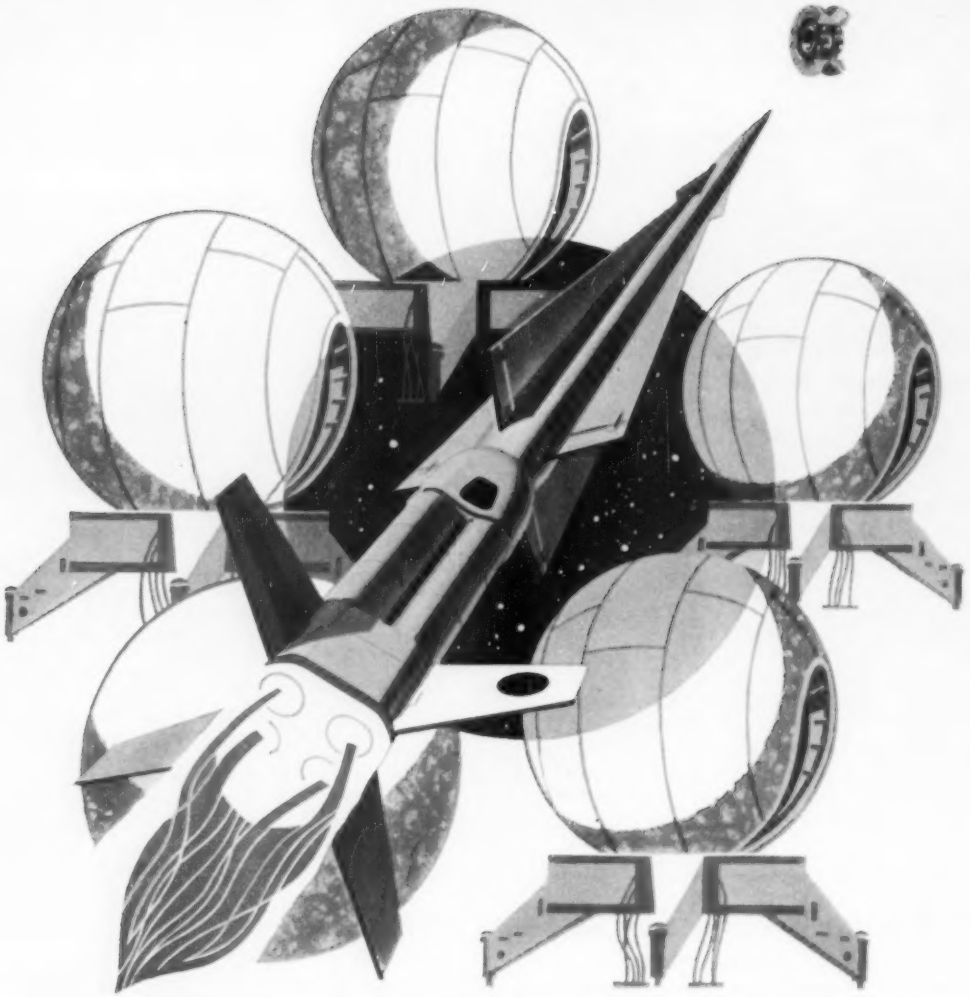

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ATLAS
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SPARROW III
NIKE HERCULES
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N/D Designs Assembly Savings Into Critical Miniature/Instrument Ball Bearings!

Helping customers *simplify* instrument assembly is a specialty of the N/D engineering group. How? Through *creative* Miniature/Instrument ball bearing application and design. Often, a new ball bearing design will produce assembly savings in excess of its additional costs. Integral ball bearings, too, very often cut down difficult and costly hand assembly of shaft and parts.

A timely example of N/D customer assembly savings can be seen in Nike Ajax and Hercules missile ground support. Here, *special* N/D Instrument ball bearings are now used in precision potentiometers. New Departure engineers recommended eliminating two *single row* instrument bearings, mounted in duplex and requiring precision spacer and separate guide roller. They replaced this assembly with a *special* N/D *double row* high precision instrument ball bearing with integral outer race guide roller . . . and shaft mounted with a nut. This one recommendation produced cost savings of over 400%! In turn, the customer was able to reduce the potentiometer selling price to the government. What's more, the New Departure Instrument Ball Bearings improved potentiometer reliability!

You can look to minimum assembly costs and unsurpassed *reliability*. Include an N/D Miniature/Instrument Bearing Specialist in your early design level discussions. For immediate information or assistance, call or write Department L.S., New Departure Division, General Motors Corporation, Bristol, Connecticut.

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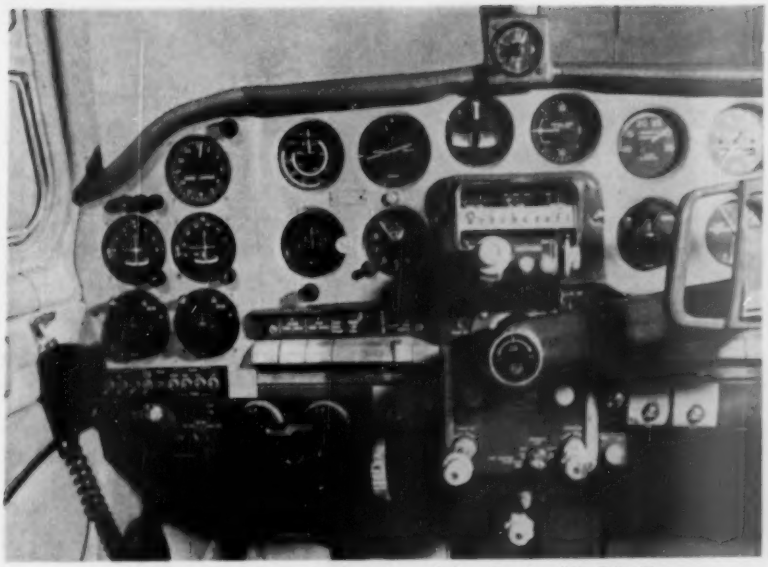

Custom Avionics Installation Made in K-35 Bonanza

Custom communications and navigation installation was made by Greensboro-High Point Air Service, Inc., Greensboro, N. C., on a Beech K-35 Bonanza owned by Engineering Equipment Co., Durham, N. C. Job entailed reworking the entire left quarter of the instrument panel. All equipment is tied into custom audio switching panel just above ADF control head. Installation includes primary communications—a crystal-controlled Narco Mk. V; two Lear LNC-100 180-channel receivers with omni; Lear LNC-100 glide path receiver; Narco three-light marker beacon receiver; Lear ADF-12-E2, and Lear LNC-100 90-channel standby transmitter.

ground level to the 20 x 20 ft. helispot site. Each plate weighs 280 lb. Plates were bolted together above steel I-beams to form a solid landing platform. Installation of steel decking is the final phase in building downtown Los Angeles' first commercial helistop.

McNeil Construction Co. President Bruce W. McNeil is chairman of the board of a new concern, Helicabs, Inc., which is slated to become Los Angeles' first helicopter taxi service to convey passengers and luggage between Los Angeles International Airport and the downtown area. The company expects to inaugurate Helicab service in three-passenger Bell 47-J ranger helicopters beginning about Feb. 1, with a flight time of about nine minutes from the airport to the downtown site.

Helicabs is currently negotiating for several additional helistop sites atop key buildings in the metropolitan Los Angeles area.

Dornier Markets Four-Seat Do.27

Munich—Dornier Do.27 STOL aircraft is now available in a four-place version in addition to the standard six-seater (AW Aug. 3, p. 104).

Dimensions and construction of both planes are identical, but the powerplant for the four-seater is a 240-hp. Continental piston engine instead of the 275-hp. Lycoming used on the six-place plane.

Four-seat Do.27 sells for about $23,000 at the factory. Standard six-place model is priced at $28,800. Gross weight of the four-seater is 3,740 lb. and useful load is 1,520 lb.

Maximum speed is 141 mph., cruise speed is 124 mph. and minimum speed in straight and level flight is 37 mph.

Takeoff distance to clear a 49.2-ft. (15 meters) obstacle is 755 ft., and landing distance over the obstacle is 590 ft. Range of the four-place craft is 497 mi.

PRIVATE LINES

New Aero Commander distributor for eastern Missouri and southern Illinois is Mark Aero, Inc., Lambert Field, St. Louis, Mo.

Helicopter taxi service from Seattle-Tacoma International Airport to both cities will go on a scheduled basis Feb. 1 using two Sud Alouette turbine-powered helicopters sold by Republic Aviation Corp. to Sea-Tac Airways, Inc. A third Alouette is expected to be put in service by Mar. 1, and the operator expects to have six of these rotary wing aircraft in service by year's end, half on scheduled taxi service and the others on contract work. Taxi charges will be approximately $6 from downtown

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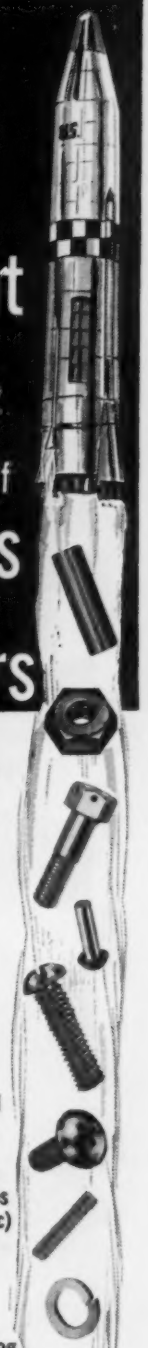

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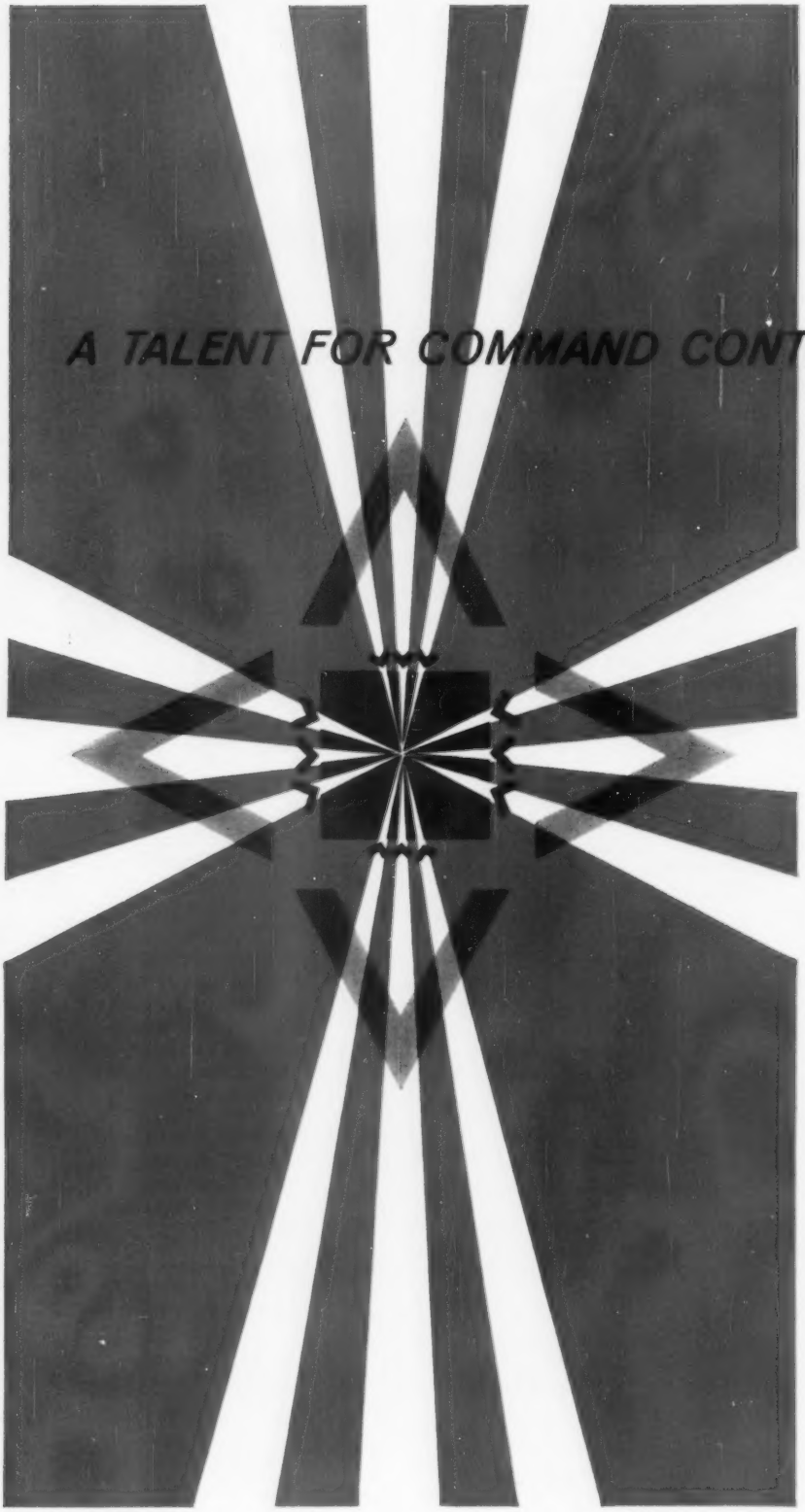

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Wichita Country Club, Kan., is the site of a ground school program developed by Yingling Aircraft, Inc., Cessna dealer, which is providing free instruction in return for use of the club's facilities for a classroom. The 18-week program is held for a two-hour period one night each week.

Sud-Aviation, France, is converting a large number of North American T-28A surplus USAF piston-engine trainers to higher-powered Nomad configuration originally developed by NAA-Columbus Division and licensed to PacAero Engineering Corp., which sublicensed the conversion to Sud. Aircraft are being reactivated at Davis-Monthan AFB, Ariz., ferried to the East Coast and then taken by French aircraft carrier to France. In November, 49 of the T-28As were ferried from Arizona and 40 more are planned monthly through May, 1960.

Distribution of smoke and fire detection equipment developed by PyroTector, Inc., Hingham, Mass., is being handled nationally on an exclusive basis by Van Dusen Aircraft Supplies. Van Dusen will also market the equipment overseas through its Teterboro, N. J., export office.

William C. Wold Associates, New York aircraft broker, reports used aircraft sales of $18,100,000 during 1959, a 100% increase over the preceding year. A total of 69 planes were sold, ranging from Convair 240s to Vickers Viscounts.

Air Taxi Co., Red Bank, N. J., will open new passenger quarters at New York International Airport Feb. 1. Air Taxi has a fleet of nine aircraft, including a new Piper Aztec. New office will be directed by J. Douglas McLaren, company sales manager. Air Taxi also will offer long distance charter flights, emergency air freight and air ambulances.

Heliport landing area for air-sea rescue work will be one of the features of the new $4 million Rockaway Beach Hospital on Long Island. Heliport will be used mainly by police and Coast Guard helicopters but will be made available for emergency service from New York International Airport, hospital said.

Belger Helicopter Service, Inc., is a new general charter commercial helicopter operation established at Kansas City, Mo. Company has purchased a Bell 47G-2. President is Larry Belger and chief pilot is Roy Lindley.

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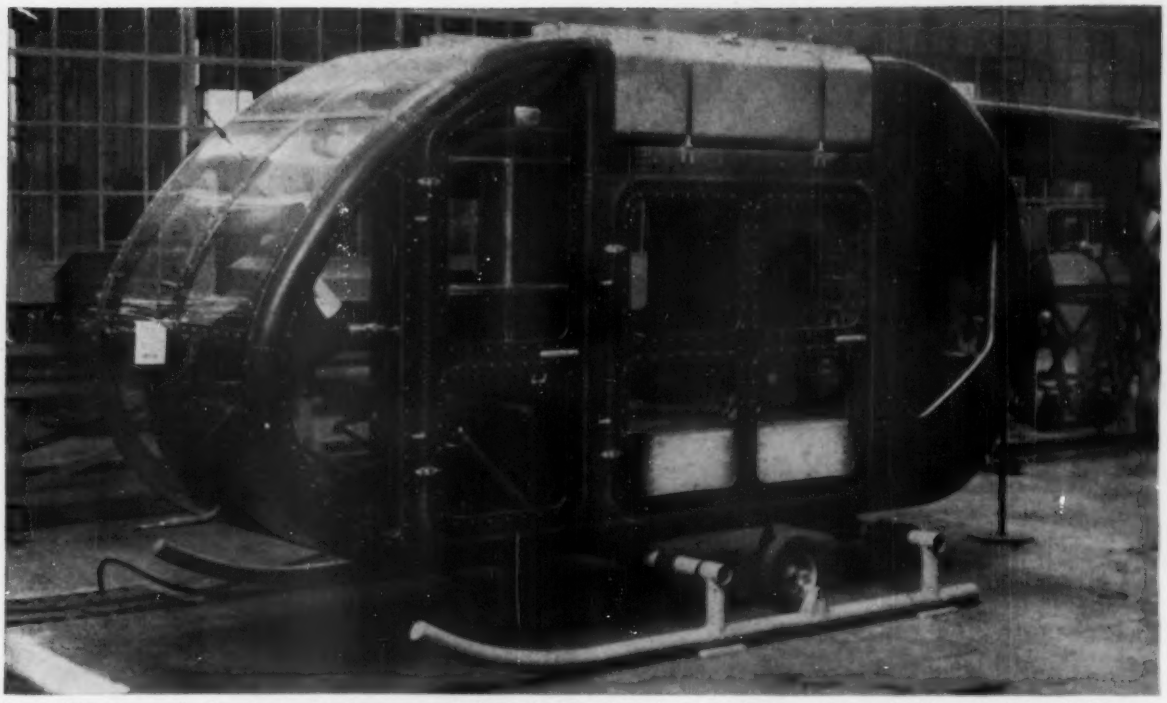
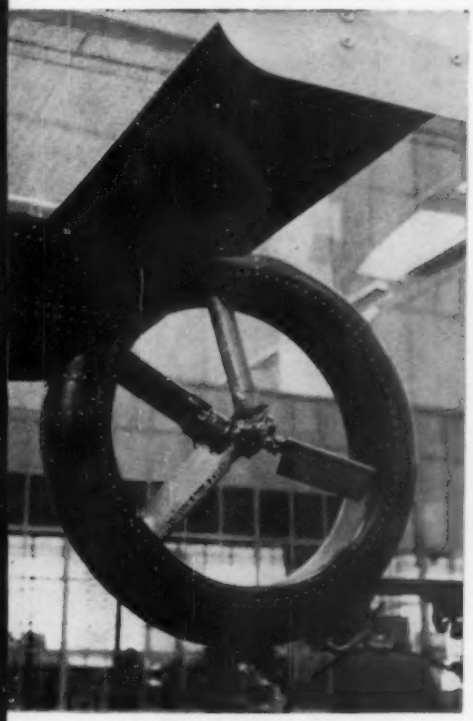


Fiat 7002 helicopter fuselage is completed except for final installations when the rotor blades are mounted. Note simplicity of the structure, large access doors to pilot's compartment and to the passenger and freight bay. Fuel tanks are strapped to central keel and side.

Fiat 7002 Cold-Jet Helicopter Nears Completion



Tail rotor (2 ft. diameter) is mechanically driven from the main rotor. Rotor blades are shrouded to improve propulsive efficiency.

Fiat's 7002 cold-jet helicopter is nearing the end of its long development program at Torino, Italy, and is expected to start flight trials within a few months.

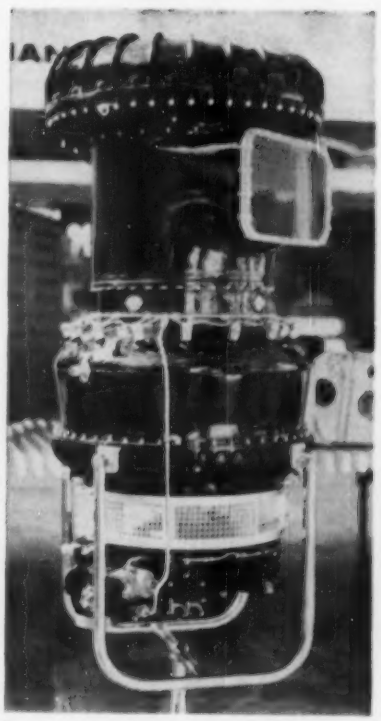
Progress with the project has been slower than expected. Major difficulty has been traceable to aero-centrifugal flutter in the two-bladed tip-driven rotor system. The problem is largely solved now.

All static tests and most of the dynamic tests have been completed with the helicopter under conditions of both steady and oscillating loads. A complete rotor hub system has been mounted in the test tower and has accumulated much running time.

Static and dynamic balancing of the blades was the most difficult job encountered during the tests, with the aero-centrifugal flutter showing up at one point. All vibration tests have been completed, and some minor modifications—including blade counterweights—have been made.

One problem which can't be fully solved on the ground is the known tendency of a two-bladed rotor to oscillate during transition from hovering to forward flight. The Fiat 7002 will have servo controls to damp these oscillations during transition phase.

The 7002 helicopter (AW Apr. 21, 1958, p. 151) is powered by a Fiat 4700 gas generator unit developing about 530 gas horsepower for takeoff, and delivering about 7.5 lb./sec. of air to the blade tips. Gross weight of the helicopter is 3,080 lb. and useful load is 1,760 lb.



Fiat gas generator unit is powerplant for the 7002 helicopter. Output is about 7.5 lb./sec., equaling about 530 gas horsepower, for takeoff conditions.

Nuclear Plane Radiation Hazards Defined

By Craig Lewis

Washington—Biomedical problems are not now considered a limiting factor in the development of a practical nuclear-powered aircraft, but U. S. research programs on the subject are continuing.

Much work remains to be done before detailed solutions are found to such problems as radiation effects, psychological stresses and potential accidents, but development of the aircraft system in the slowly moving Aircraft Nuclear Propulsion program does not hinge on these solutions.

"While the biomedical problems associated with nuclear powered flight are difficult, they are not considered as limiting the development of practical nuclear powered aircraft," according to Lt. Col. Charles M. Barnes, ANP life sciences project officer.

In the years of biomedical research paralleling development of the nuclear aircraft, problems of protecting the crew and the public in case of an accident have been major considerations. Safety problems connected with operation of nuclear powerplants in the atmosphere are currently under study by the Atomic Energy Commission's Aerospace Nuclear Safety Board established last year, and this group's first report is expected soon.

Safety Hazards

A large nuclear-powered aircraft presents the same safety hazards as any large aircraft plus the additional hazard of radiation contamination in a crash. However, Col. Barnes feels that loss of life need not be much greater than with conventional aircraft of the same size.

He said it has been shown statistically that, if nuclear powered aircraft are operated under planned procedures over sparsely populated areas, "additional mortality will be negligible. A small additional risk seems acceptable, particularly when the operational advantages of nuclear systems are compared with conventional aircraft."

Current operational plans call for the nuclear aircraft to be flown under carefully controlled flight conditions. In peacetime, flights would be restricted to air corridors over sparsely populated areas. This is an established technique, since corridors already have been set up for operation of Strategic Air Command bombers away from large population centers.

The nuclear aircraft also will be constantly tracked by radar to provide fast data in an emergency and to pinpoint a crash site. Flights will be planned with weather conditions in mind so that, if possible, the aircraft will fly in weather that would tend to disperse radioactive matter in case of a crash.

If an emergency occurs in the air and the crew members leave the airplane, they will eject themselves from their shielded cabin in escape capsules which will protect them from wind blast and provide a habitable environment during descent and rescue operations. These escape capsules will not be shielded against radiation because they will be ejected past the reactor zone so fast that the dose received by the crewmen will not be biologically measureable and will be about equal to the dose received during a typical mission.

When the nuclear aircraft design progresses to the point where it needs escape capsules, the capsule state of the art for conventional aircraft is expected to fill the need without special design for radiation considerations. Radiation plus the thick escape doors from the shielded cabin are the only departures from conventional requirements.

If the aircraft crashes, damage to the reactor powerplant will release fission products to the surrounding atmosphere. Heat from the reactor and from any chemical fire that started would tend to loft the radioactive particles. Distribution of these particles depends on particle weight, wind velocity and direction. Wind effect is the reason behind the attempt to find weather conditions favorable for particle dispersion. Under adverse conditions, a pencil-shaped area downwind would be contaminated.

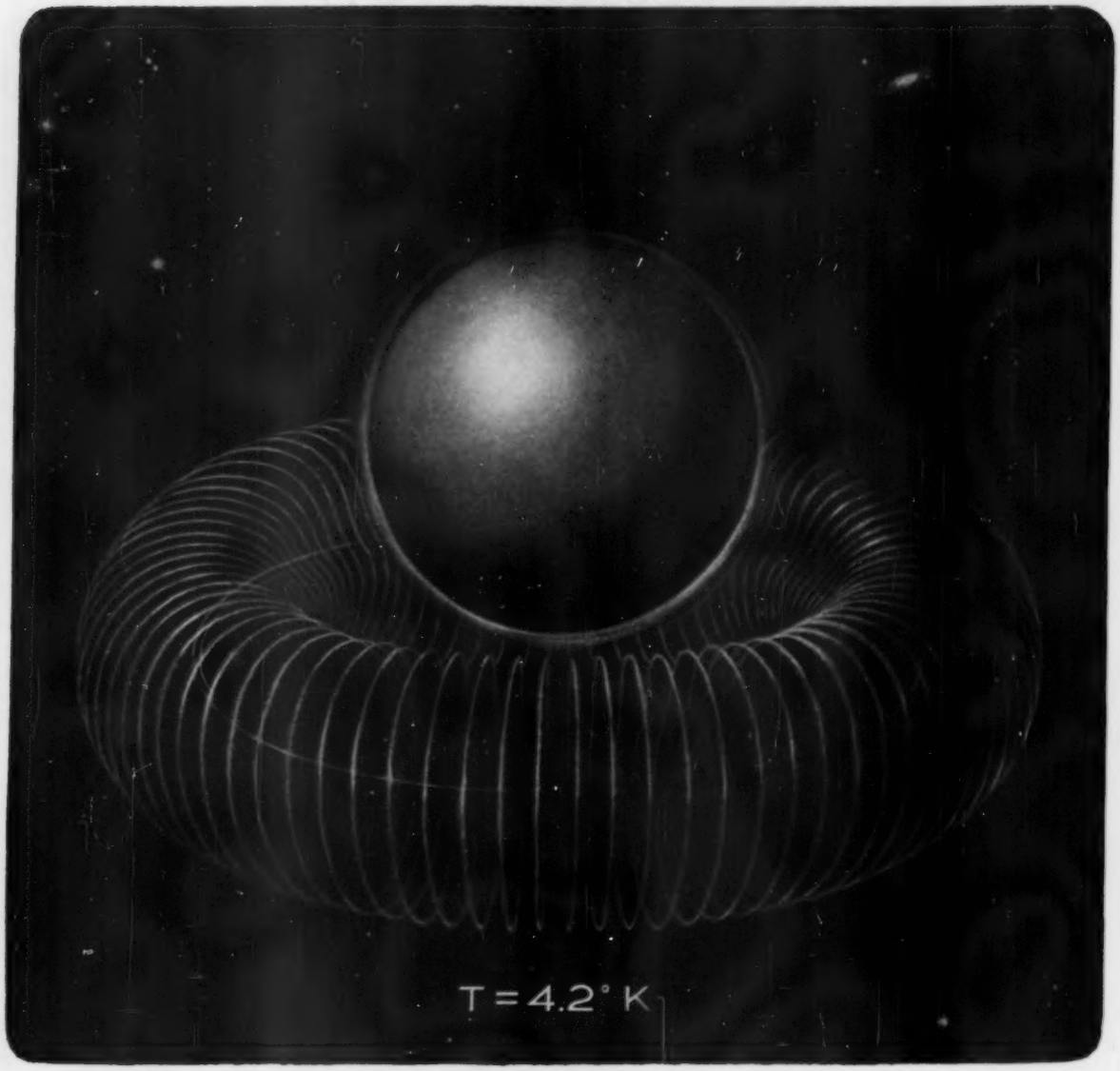
Crash Techniques

Countermeasures are under study to deal with the consequences of a crash. Firefighting techniques are being examined to determine the best way of approaching the wreckage and to find the best technique among such possibilities as using helicopters for an air approach or using remote controlled ground vehicles. Foams and chemicals are under study which would form a thick mass over the wreckage and filter out fission products. There is also a requirement for some means of identifying wreckage posing a radiation hazard, and this could possibly take the

Saab J-35C Trainer Begins Flight Program

First flight of the J-35C, two-seat trainer version of the Saab Draken Mach 2 fighter, was made recently with Saab pilot K. E. Fernberg at the controls. Production of the trainer is now running parallel with that of the single-place fighter version. Deliveries of the J-35C are scheduled to begin this year. Royal Swedish Air Force will use the trainer in conjunction with a Curtiss-Wright flight simulator in a combined program at a central type-training school. The J-35C is identical to the standard fighter in every respect except for the forward fuselage, which has been modified to accommodate instructor and pupil. Rear seat has been elevated for better visibility for the instructor. Both seats are Saab ejection type. Space for the extra crewman was made by eliminating some of the equipment from the standard fighter, presumably the fire-control gear.

IMPORTANT DEVELOPMENTS AT JPL



THE CRYOGENIC GYRO

A fundamentally new type of gyroscope with the possibility of exceptionally low drift rates is currently under development. The design techniques used in conventional electro-mechanical gyros appear to have been largely exploited. A break-through is needed, and the cryogenic gyro may well provide it.

The cryogenic (liquid helium temperatures, in the range of 4°K) gyro consists of a superconducting sphere supported by a magnetic field. The resulting configuration is capable of support in this manner as a result of a unique property of a superconductor. Exceptionally low drift rates should be possible. This cryogenic gyro has performance potential unlimited by the constraints of conventional electro-mechanical gyros.

This is just one example of the intriguing solid state concepts which are being pioneered at JPL for meeting the challenge of space exploration. In addition to gyro applications, superconducting elements are providing computer advances and frictionless bearings. The day of the all-solid-state space probe may be nearer than one realizes.

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form of a smoke bomb, beacon or painting the aircraft distinctively.

The firefighting, rescue and cleanup job probably will be done with remote controlled, shielded vehicles. If the crew is in the aircraft when it crashes, it is expected to stay in the shielded crew cabin because of the thermal and radiation protection it provides. However, if an injured crewman requires quick removal, something similar to a shielded version of the World War II tank repair vehicle could be used to either cut the cabin open and remove the crew or to remove the entire cabin from the wreckage.

Simulated Crash Tests

Experiments with fission products released from a simulated aircraft crash are being conducted at Dugway Proving Grounds, Utah, and the National Reactor Testing Station in Idaho. These experiments deal with the type and amount of fission products released, the area they would cover under various meteorological conditions, their effect when inhaled by experimental animals, and countermeasures useful in limiting the consequences of the release of fission products.

With the range provided by nuclear power, nuclear aircraft crews will be flying missions on the order of 100 hr. long. The radiation dose rate on missions of this length is low enough so that such other factors as fatigue and boredom, rather than radiation, will determine flight time limits.

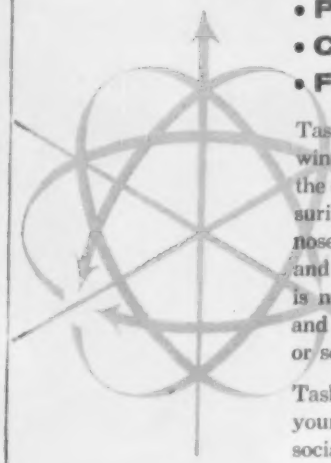
Based upon various human and animal studies, a tolerance dose of 200 Rem (Roentgen equivalent man, which is a measure of absorbed energy) has been suggested for nuclear aircraft crewmen, although they might not reach that limit. This cumulative dose would be acquired over a 10-year period of operation at an average rate of about 20 Rem a year. This is higher than the occupational dose recommended for industry, but it involves a small group working under different conditions. Crews will be composed of senior volunteer pilots who already have had their families.

Total dose limits might be raised in view of animal experiments which indicate there is a recovery factor when radiation doses are spaced out. Thus, use of rest periods between flight doses might permit an increase in the total dose absorbed.

Air Force has some experience with crew shielding problems in actual operation, gleaned from the 47 flights of a converted Convair B-36 (AW Dec. 22, 1958, p. 64). This nuclear test aircraft used the split shielding technique of shielded cabin and separate shadow shield between cabin and reactor which is expected to be used in an operational nuclear aircraft. Although the reactor

TASK

Force and Moment Measurement Systems



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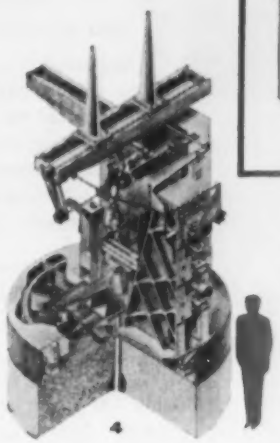
1. **Six component internal strain gage balance,** 8" outside diameter. Largest ever produced.
2. **Six component calibration rig** designed and built for ARO, Inc.



3. **Stick Force Dynamometer**—Two component (elevator and aileron) temperature compensated force transducer. Uses: flight test, flight simulator, flight control servo feedback element.
4. **Six component external balance** built for Norair, a Division of the Northrop Corporation.

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P5M-1
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[redacted] creates experience

To date ERCO is the largest supplier of ASW tactics trainers to the U.S. Navy.*

The prime requisite in the design and ultimate construction of these units is Systems Comprehension. To its Systems Comprehension ERCO adds Human Engineering so the many subsystems that make up an ASW airborne system can be successfully integrated . . . not only for training purposes but for the mission itself.

As a result of designing the complete tactics trainer, with the overall system requirement as the criteria, ERCO has acquired the position of being an objective observer. By combining the knowledge gained through building ASW tactics trainers . . . along with our Special Purpose Computing Techniques . . . we have under development the AID (Automatic Integrated Display).

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operated in the air in these NB-36 radiation air scatter experiments was considerably less powerful than the power source for a nuclear aircraft, the flights are considered a successful demonstration of the safety possible in operating a reactor in the air and handling it on the ground. Crew dosages were well below Atomic Energy Commission tolerances in these flights, and the crewmen involved are not under study.

Immunization Drugs

Researchers are now conducting a search for drugs that would provide immunity to radiation damage. University of Chicago has a contract to screen numerous drugs to find a protective agent, and the AEC facility at Oak Ridge, Tenn., is looking for protection from chronic effects of radiation. Drugs have been found which impart immunity to some animals but not to others, so no universal protective is currently available.

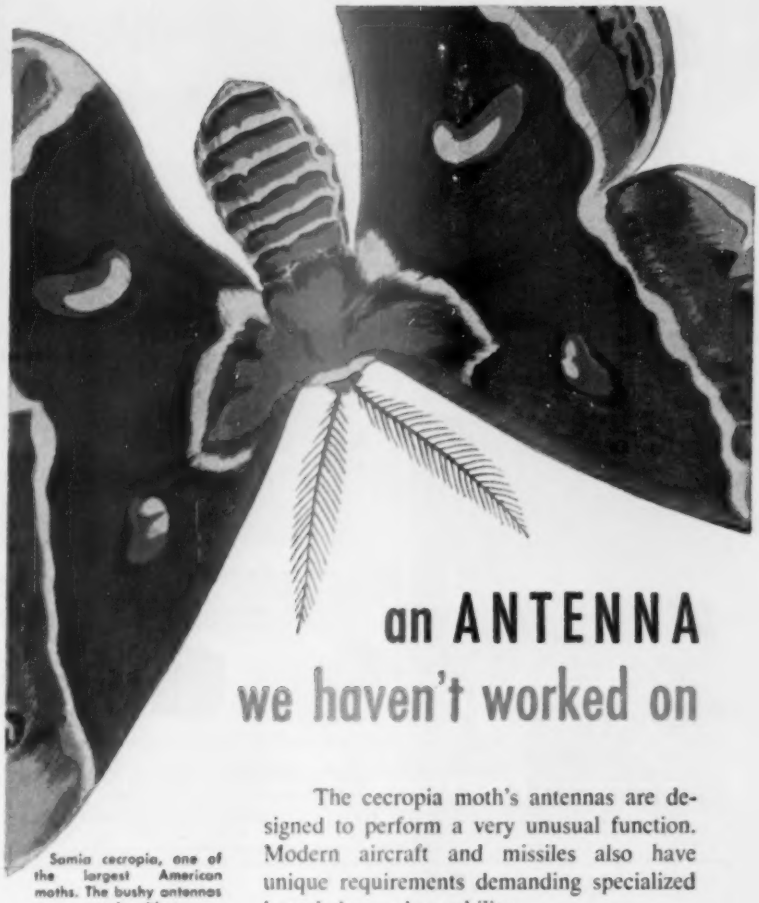
The potential psychological hazards with crewmen flying missions of 100 hr. or more are considerable, although the use of experienced, knowledgeable people, such as combination pilots and nuclear engineers, is expected to minimize these hazards. Living conditions and work cycles are under study at such facilities as the Lockheed Aircraft Corp. Georgia Division and the Aerospace Medical Laboratory at Wright-Patterson AFB to determine optimum conditions for long duration flights.

To ease physical and psychological problems on long flights, the nuclear aircraft cabin will be considerably more luxurious than normal large aircraft crew compartments. It probably will have music piped in to combat the dead silence in the highly insulated cabin. Silence was a problem on the NB-36 flights, especially for pilots used to monitoring their engines by their sounds.

Cabin will be pressurized, air will be filtered, and the crewmen will not be hampered by the discomfort of tight flight suits because the nuclear aircraft probably will not cruise at the extreme altitudes encountered by modern turbojet aircraft. For emergencies, the individual escape capsules will provide the oxygen and other supplies needed. Radiation dosimeters will be attached to crew members and the cabin interior to measure dose levels.

Longevity Studies

One means of studying the possible effects of radiation doses on crewmen is to irradiate animals and then run longevity studies on them. Tests already have shown that the relatively short life span of a rat can be shortened by irradiating it, and tests are now being conducted with longer-lived animals. A group of monkeys has been irradiated



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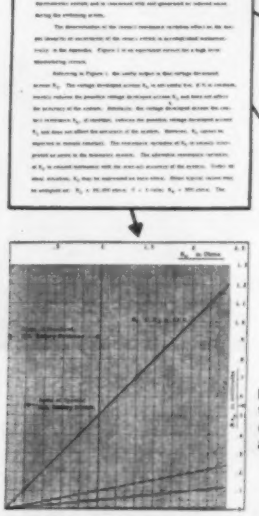

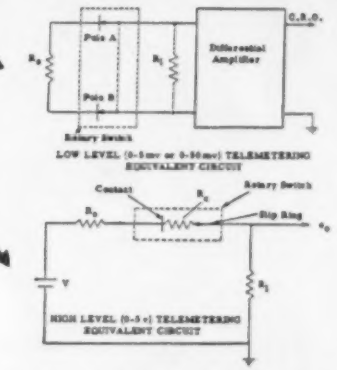

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and gone through seven years of study thus far.

A group of donkeys, whose total bulk is closer to that of man, is under study at the University of Tennessee, and AEC has about 500 beagles under study at the University of California at Davis, Calif. All these dogs are female, and they have been bred each of the five years since they were irradiated. Until recently, the irradiated group was producing bigger litters than the non-irradiated control group but now the latter is catching up.

All of these animals are kept in carefully controlled and protected environments and watched closely for long-term radiation effects.

Not all the radiation research used in planning nuclear aircraft operations is the result of ANP programs. Much work of general interest, such as the search for a protective drug, is done by AEC and other groups. ANP office finances and manages only those programs directly related to nuclear aircraft problems on work which is not being done elsewhere. Among the groups working in the ANP biomedical program are the School of Aviation Medicine at Brooks AFB, Texas, and research groups at Kirtland AFB, Wright Air Development Division and Air Force Cambridge Research Center.

Aerodynamics School Accepts Applications

Rhode-Saint-Genese, Belgium—Entry applications from graduate engineers and scientists for a one year course in experimental aerodynamics for the academic year starting Oct. 3, 1960, and ending July 1, 1961, are now being accepted by the Training Center for Experimental Aerodynamics here.

The center was founded in 1956 as an international institution, under the chairmanship of Dr. Theodore von Karman. Wind tunnel laboratories are located near Brussels. There are no fees for the course and a number of student fellowships are available.

Further information and application forms may be obtained from L.G.H. Sterne, center director, 72 Chausee de Waterloo, Rhode-Saint-Genese, Belgium. Condition of entry is fluency in either English or French, and citizenship in one of the NATO nations.

PRODUCTION BRIEFING

General Electric's Production Engine Department has received follow-on orders worth more than $27.5 million for production of J79 turbojet engines and support equipment.

De Laval Separator Co., Poughkeepsie, N. Y., will supply jet fuel purifiers

Dassault Communaute in Flight Test Stage

Dassault 415 Communaute (AW June 22, p. 75) has completed qualification and evaluation tests at the French air force flight test center, Istres. The transport's Turbomeca Bastan turboprops develop 840 shp. at takeoff, permitting takeoffs in less than 985 ft. in cleaned-up configuration. Aircraft is now undergoing company flight tests.

for Navy aircraft carriers under $1 million contract. The model B-214 centrifugal purifier removes dirt and water from jet fuel on a continuous basis. Deliveries on the production order will be completed by the end of 1960.

Budd Co.'s Defense Division has been renamed the Space Atomics Division in keeping with the division's increased emphasis in the space and nuclear areas. Activities which prompted the name change include the development of solid rocket cases and production of Zircaloy assemblies for submarine nuclear reactors.

Industrial Acoustics Co., New York, N. Y., will supply its universal type attaching noise suppressor to United Air Lines and Air France. The suppressor is adaptable to both the Boeing 707 and Douglas DC-8 jet transports.

Ryan Aeronautical Co. will build fuselage sections for the Boeing KC-135 jet tanker-transport under a $6 million follow-on contract awarded by U.S. Air Force.

Sikorsky Aircraft has received more than $4 million worth of contracts from U.S. Army and Navy for automatic stabilization kits for the H-34 ($1,215,884); technical support for H-19, H-34 and H-37s ($1,467,263), and HSS-2 spare parts ($1,817,622).

Perkin-Elmer Corp., Norwalk, Conn., will produce alignment theodolites for the Martin Mace surface-to-surface tactical missile under $2 million Air Force contract. Electro-optical theodolites are used to align the AC Spark Plug inertial guidance system for TM-76B Mace missile.

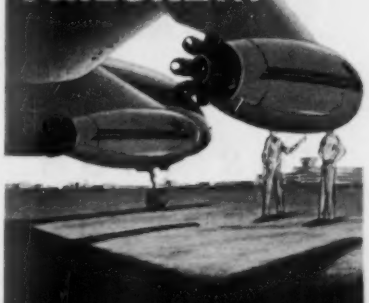
Pacair, Inc., subsidiary of Pacific Airmotive Corp., has begun shipping 245 converted North American T-28As to French government for use in Algeria. Pacair converted the trainers to fighter-bombers.

Waste King Corp.'s Technical Products Division, Los Angeles, will produce air data probes under contracts totaling $250,000. The probes, used to sense the altitude and airspeed of supersonic aircraft and missiles, were ordered by the Air Force, Lockheed, Fairchild and North American Aviation.

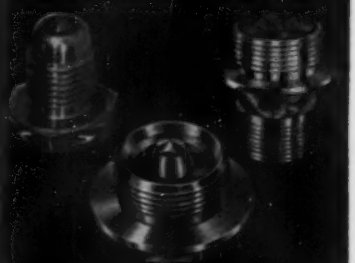
United States Chemical Milling Corp., Manhattan Beach, Calif., will move its Flotrusion Division from Glendale to Manhattan Beach. The Flotrusion technique cold flows metals into tubular forms.

Antenna Systems, Inc., Hingham, Mass., is a newly formed organization devoted to the design and production of reflectors, feeds, waveguide, rotary joints, towers, pedestals and other related antenna equipment. The first standard product of the company is a 30-ft. reflector antenna.

SIMPLEST LOWEST COST SAFEGUARD AGAINST IN-FLIGHT FAILURE...



LISLE *Magnetic* CHIP DETECTORS



Lisle Magnetic Chip Detectors provide a quick, positive means of determining the presence of ferrous particles or chips in the lubricant of aircraft engines or accessory units.

Attracted by a powerful Alnico magnet, the particles bridge an insulated gap and complete an electrical circuit which can be checked with a continuity tester.

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Retired Officers' Salaries Detailed

Washington—Following are the salaries paid to retired flag and general officers employed by the 100 largest defense contractors as reported to the House Armed Services Investigating Subcommittee in reply to questionnaires sent to both industry contractors and the individuals concerned. Salaries were released in the subcommittee's report on the employment of former regular officers by defense contractors (AW Jan. 18, p. 26).

Generals and Admirals

• **General Dynamics Corp.**—J. T. McNarney, $25,000.
• **Chance Vought Aircraft, Inc.**—H. B. Salada, $33,000.
• **Radio Corp. of America**—W. B. Smith, $14,000.
• **Ford Motor Co.**—W. G. Wyman, $22,000.
• **Fairchild Engine & Airplane Co.**—J. L. Devers, $13,000; R. B. Carney, $12,000.
• **Avco Corp.**—S. S. Murray, $90 per day.
• **International Telephone & Telegraph Corp.**—J. E. Gingrich (1).
• **Thompson Ramo Wooldridge, Inc.**—B. W. Chidlaw, $67,000; James L. Doolittle, $50,000.
• **Bath Iron Works Corp.**—R. B. Carney, $21,000.
• **Westinghouse Electric Corp.**—R. B. Carney, $6,000.

Lieutenant Generals, Vice Admirals

• **General Dynamics Corp.**—E. S. Land, $10,000; F. P. Mulcahy, $5,000.
• **Lockheed Aircraft Corp.**—C. C. Smith, $10,000; M. E. Murphy, $6,000; A. B. Vosseller, $23,000.
• **United Aircraft Corp.**—M. R. Greer, $5,000; D. L. Putt, $17,000.
• **Douglas Aircraft Co.**—I. C. Eaker, $33,000.
• **Hughes Aircraft Co.**—S. R. Michelsen, $13,000.
• **Sperry Rand Corp.**—L. R. Groves, $37,000.
• **Chance Vought Aircraft, Inc.**—H. Sanders, $17,000.
• **Radio Corp. of America**—E. D. Foster, $23,000.
• **Northrop Corp.**—R. M. Ramey, $27,000; P. W. Timberlake, $27,000; E. C. Whitehead, $13,000.
• **General Motors Corp.**—T. J. Hedding, $13,000.
• **Grumman Aircraft Engineering Corp.**—J. F. Bolger, $23,000; F. M. Trappnel, $13,000.
• **Bendix Aviation Corp.**—C. B. Monsen (1)
• **International Telephone & Telegraph Corp.**—R. H. Cruzen, $19,100.
• **Avco Corp.**—C. S. Irvine, $46,800.
• **Burroughs Corp.**—R. J. Canine, $6,000; H. D. Baker, $9,000.
• **Thompson Ramo Wooldridge, Inc.**—H. L. George, $50,000.
• **The Garrett Corp.**—K. B. Wolfe, $50,000; S. B. Spangler, $16,000.
• **Lear, Inc.**—B. M. Giles, $10,000.
• **Marine Transport Lines**—W. M. Callaghan, $14,000.
• **Ryan Aeronautical Co.**—C. F. Coe, $12,000.

Major Generals, Rear Admirals

• **Boeing Airplane Co.**—H. R. Oldfield, $13,000; C. S. Weeks, $8,000; H. M. Marshall, $6,000; G. P. Galpin, $6,000.

(1) *Not given*

• **General Dynamics Corp.**—E. P. Abernathy, $6,000; S. H. Ambruster, $4,000; C. Briggs, $6,000; T. H. Dubois, $5,000; W. O. Floyd, $6,000; G. L. Heach, $6,000; C. F. Horne, $12,000; J. H. Kaufman, $5,000; S. Leith, $9,000; J. R. Pahl, $8,000; L. B. Richardson, $33,000; W. B. Whaley, $7,000; H. Wood, Jr., $6,000; T. B. Klakring, $13,000; R. L. Gross, $11,000; W. A. Lent, $7,000; J. R. Z. Reynolds, $13,000; W. V. R. Vieweg, $14,000; H. F. Stout, $6,000.
• **General Electric Co.**—C. Adair, $13,000; H. S. Hansell, $30,000; T. C. Lonnquest, $8,000; H. M. Roper, $18,000; W. T. Kinsella, $12,000; P. W. Watson, $9,000.
• **United Aircraft Corp.**—J. F. Byrne, $12,000.
• **Douglas Aircraft Co.**—[illegible] H. Eckelmeyer, Jr., $12,000; L. DeFlores, $3,000.
• **The Martin Co.**—F. R. Dent, Jr., $21,000; R. S. Purvis, $14,000; R. J. Foley, $9,000; S. S. Miller, $10,000; M. C. Reeves, $9,000; K. E. Tibbetts, $21,000; V. Harvard, Jr., $8,000.
• **Hughes Aircraft Co.**—N. F. Garton, $15,000; M. S. Nation, $15,000.
• **Sperry Rand Corp.**—C. Whitney, $21,000.
• **Chance Vought Aircraft, Inc.**—A. H. Perry, $13,000.
• **McDonnell Aircraft Corp.**—S. W. Souers, $4,000; Lloyd Harrison, $21,000.
• **International Business Machines Corp.**—T. C. Odom, $25,000.
• **Radio Corp. of America**—W. L. Richardson, $18,000; F. L. Ankenbrandt, $22,000; L. M. Grant, $12,000; H. S. Harnly, $12,000; R. R. Waller, $11,000; T. P. Wynkoop, $19,000; E. K. Wakefield, $7,000; J. M. Robinson, $7,000; L. R. Lampman, $10,000; H. C. Ingles, $10,000; C. C. Mann, $13,000.
• **Northrop Corp.**—M. P. Bagdanovich, $10,000.
• **General Motors Corp.**—B. D. Smith, $9,000.
• **Republic Aviation Corp.**—A. R. Crawford, $33,000.
• **Chrysler Corp.**—D. C. MacMillan, $10,000; R. B. Tompkins, $14,000.
• **Grumman Aircraft Engineering Corp.**—F. J. McKenna, $75 per day.
• **Raytheon Manufacturing Co.**—G. M. Richardson, $10,000.
• **Curtiss-Wright Corp.**—L. V. Julian, $13,000.
• **Bendix Aviation Corp.**—W. E. Cleaves, $18,000; P. D. Gallery, $75 per day.
• **General Tire & Rubber Co.**—C. M. Bolster, $20,000; J. C. Alderman, $10,000; R. K. Ashton, $9,000; L. C. Baldauf, $13,000; R. S. Hatchey, $14,000; A. W. Vanaman, $13,000; A. D. Hunter (1).
• **Fairchild Engine & Airplane Corp.**—H. O. Hauck, $25,000.
• **International Telephone & Telegraph Corp.**—C. R. Smith, $26,000; R. C. Maude, $22,000; E. H. Leavy, $84,000; F. H. Lanahan, $33,000; J. Sowell, $14,000; W. Organ, $15,000; F. R. Furth, $27,000; W. L. Freseman, $16,000; R. E. Laub, $13,000.
• **Avco Corp.**—H. M. Jones, $19,000; W. T. Griffith, $180 per day; E. L. Woodward, $10,000.
• **Burroughs Corp.**—S. B. Dunlap, $8,000.
• **Philco Corp.**—M. D. Burnside, $13,000; R. S. Mandelkorn, $20,000; J. E. Leeper, $17,000.
• **Thompson Ramo Wooldridge, Inc.**—G. P. Saville, $37,000.
• **Cities Service Co.**—J. M. Rose, $14,000.
• **Collins Radio Co.**—A. S. Born, $14,000.
• **Olin Mathieson Chemical Corp.**—R. T. Cowdrey, $16,000.
• **Food Machinery & Chemical Corp.**—H. A. Carlisle, $9,000.
• **Goodyear Tire & Rubber Co.** — K. L. Lange, $9,000.
• **Thiokol Chemical Corp.**—D. F. O'Neill, $8,000.
• **Newport News Ship & Dry Dock**—N. L. Rawlings, $36,000; R. A. Larkin, $7,000.
• **General Precision Equipment Co.**—S. E. Burroughs, Jr., $20,000; M. F. Schoeffel, $21,000; J. A. McNally, $13,000; G. T. Mundorff, $15,000; J. A. Scott, $13,000; S. H. Barnard, $10,000.
• **Bethlehem Steel Co.**—H. L. Collins, $13,000; W. R. Dowd, $8,000.
• **Rand Corp.**—W. T. Jones, $10,000; H. G. Bunker, $19,000.
• **Kaman Aircraft Corp.**—J. A. Thomas, $17,000.
• **Motorola, Inc.**—J. C. Parham, $12,000.
• **Temco Aircraft Corp.**—A. C. Olney, $12,000.
• **Fairbanks-Whitney Corp.**—C. Broussard, $5,000.
• **Ryan Aeronautical Co.**—E. R. Sanders, $12,000; L. E. Gehres (1), K. J. Christoph (1); H. A. Hummer, $6,000; L. C. Chamberlin, $6,000.
• **Union Carbide Corp.**—W. V. Hamilton, $12,000.
• **Westinghouse Electric Corp.** — A. Boyd, $50,000; W. V. Deutermann, $12,000; H. T. Walsh, $10,000; E. S. Keats, $12,000; W. L. Kabler, $12,000; L. J. Dow, $20,000.
• **Lockheed Aircraft Corp.** — E. B. Lyon, $9,000; W. J. Whipple, $10,000; E. E. Lord, $18,000; C. R. Doerflinger, $10,000; C. D. Emory, $5,000; E. A. McFall, $7,000; W. M. Klee, $11,000; G. B. Dowling, $12,000; T. R. Frederick, $8,000; H. I. Dyson, $10,000; J. F. Quilter, $8,000; W. L. Tagg, $10,000; P. E. Summers, $11,000; R. E. Metcalf, $9,000; W. A. Bowers, $6,000; W. R. Smith III, $8,000; W. H. Newton, $13,000; G. E. Short, $8,000; J. F. Taylor, $9,000.
• **North American Aviation, Inc.**—W. B. Jackson, $11,000; J. L. Melgaard, $12,000; J. B. Pearson, Jr., $30,000; J. H. Hinds, $12,000; G. A. Whiteside, $17,000; S. W. Carpenter, $11,000; F. Turner, $14,000.

Brigadier Generals

• **Boeing Airplane Co.**—J. C. Crosthwaite, $8,000.
• **General Dynamics Corp.**—M. W. Arnold, $33,000; E. P. Pennebacker, Jr., $9,000; R. L. Peterson, $6,000; W. L. Baker, $18,000; W. J. Piper, Jr., $6,000.
• **Lockheed Aircraft Corp.**—H. Prindle, $9,000; H. O. Deakin, $7,000; M. H. Floom, $9,000; J. S. Blais, $9,000; H. P. Becker, $6,000.
• **United Aircraft Corp.**—E. C. Dyer, $10,000; T. A. Sims, $33,000; H. R. Lee, $8,000.
• **Douglas Aircraft Co.**—O. F. Carlson, $17,000; S. L. McCroskey, $13,000.
• **The Martin Co.**—E. S. Piper, $8,000; S. S. Ballentine, $8,000.
• **Hughes Aircraft Co.**—W. L. S. Bayler, $6,000; F. W. Coleman, $10,000.
• **Sperry Rand Corp.**—J. A. Bulger, $14,000.
• **Radio Corp. of America**—S. P. Collins, $9,000; T. J. Tully, $10,000.
• **Republic Aviation Corp.**—C. P. Brown, $17,000; H. S. Jones, $100,000; J. M. Sterling, $21,000.
• **Chrysler Corp.**—J. W. Horridge, (1).
• **Raytheon Manufacturing Co.**—F. A. Kriedel, $10,000.
• **General Tire & Rubber Co.**—F. F. Hayden $7,000; R. W. Hayward, $9,000; H. Shaler, $11,000; D. L. Van Syckle, $9,000.
• **Fairchild Engine & Airplane Corp.**—W. W. Welsh, $13,000; J. F. Early, $9,000.
• **International Telephone & Telegraph Corp.**—P. M. Seleen, $11,000; James S. Willis, $14,000; K. E. Fields, $3,000.
• **Avco Corp.**—M. MacCloskey, $19,000.
• **Thompson Ramo Wooldridge**—W. M. Garland, $20,000.
• **Hayes Aircraft Corp.**—W. W. Wise, $11,000.
• **Food Machinery & Chemical Corp.**—J. A. Holly, $18,000.

(Continued on page 125)

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MELPAR APPLIES ELECTRONIC CREATIVITY TO SEVEN PRINCIPAL AREAS OF ACTIVITY

DETECTION & IDENTIFICATION—Melpar has exceptionally broad experience in data analysis. Melpar designs and develops special equipments and systems for early detection and identification. A large engineering capability has been assembled in these areas. New detection-identification methods and techniques are constantly being developed.

ANTENNAS AND RADIATION—Equipped with the best research and development facilities, Melpar is able to reduce customers' requirements to physical equipments. Melpar, supporting its leadership in advanced concepts, has established 19 antenna test ranges for proof of performance. Also, Melpar provides a unique quick reaction facility through its "follow on" production. The Company's experience in new ordnance and electronic countermeasures systems is currently being applied to the nation's newer missile and satellite programs.

FLIGHT SIMULATION & TRAINING—Concurrent design and development of simulation and training equipment that matches the exacting demands of new aircraft schedules gives Melpar proved ability to design and develop complete mission-type simulators for fixed and rotary-wing aircraft, radar and fire control, and missiles. Melpar excels in the ability to derive and reproduce system analogs rapidly while accurately preserving all of the original equipment's tolerances.

COMMUNICATION & NAVIGATION—Leading in the application of novel printed circuit techniques to achieve a new order of miniaturization and compact design, Melpar is responsible for many innovations and new concepts in data transmission links, microwave receivers, communication terminal equipment, secure communications devices, and remote control systems. Melpar maintains extensive field operations, including a facility at Tucson, Arizona, where avionic equipment and systems are studied, installed, and tested for the Army's Electronic Proving Ground (Fort Huachuca).

PHYSICAL SCIENCES—Recognizing the need for a partnership between electronics and physical sciences, Melpar has established a materials research laboratory within its electronics complex. Research on the structure and application of new materials to support electronics is advancing at Melpar. Experienced research staffs are now evolving practicable, workable designs in such areas as high temperature effects on materials and molecular electronics.

...proved ability, experience assure electronic achievement

MELPAR'S ENGINEERING DIVISION makes a continuing creative contribution to electronic development. And a number of significant electronic achievements have resulted from Melpar's imaginative approach to project and system engineering.

Electronic achievement at Melpar resulted in the conception, design, and production of one of the largest airborne electronic systems ever developed—the first integrated electromagnetic reconnaissance system . . . and two of the largest ground electronic systems—a ground based reconnaissance data handling system, and the F-101B weapon system simulator.

MELPAR EQUIPMENTS form an integral part of many advanced weapons systems, and equipment developed at Melpar will comprise a part of the first manned-satellite launched into orbital flight.

DATA HANDLING—Melpar designs, develops, and produces fully automatic data handling systems with both tremendous data gathering capacity and the ability to process results in a relatively short time. New approach philosophies have been applied to the development of special purpose computers, tactical displays for weapons systems, and systems for both data reduction and data processing. Melpar has full data handling resources, with a broad range of customer services—from problem analysis to complete system design.

RECONNAISSANCE—Early design and development experience with reconnaissance systems led Melpar to recognition of the possibilities inherent in new reconnaissance techniques. Now, Melpar, leads the industry in the development, design, and production of reconnaissance systems that incorporate new and sophisticated techniques. One example of Melpar's leadership in this area is the conception, design, and production of one of the largest airborne electronic systems ever developed.

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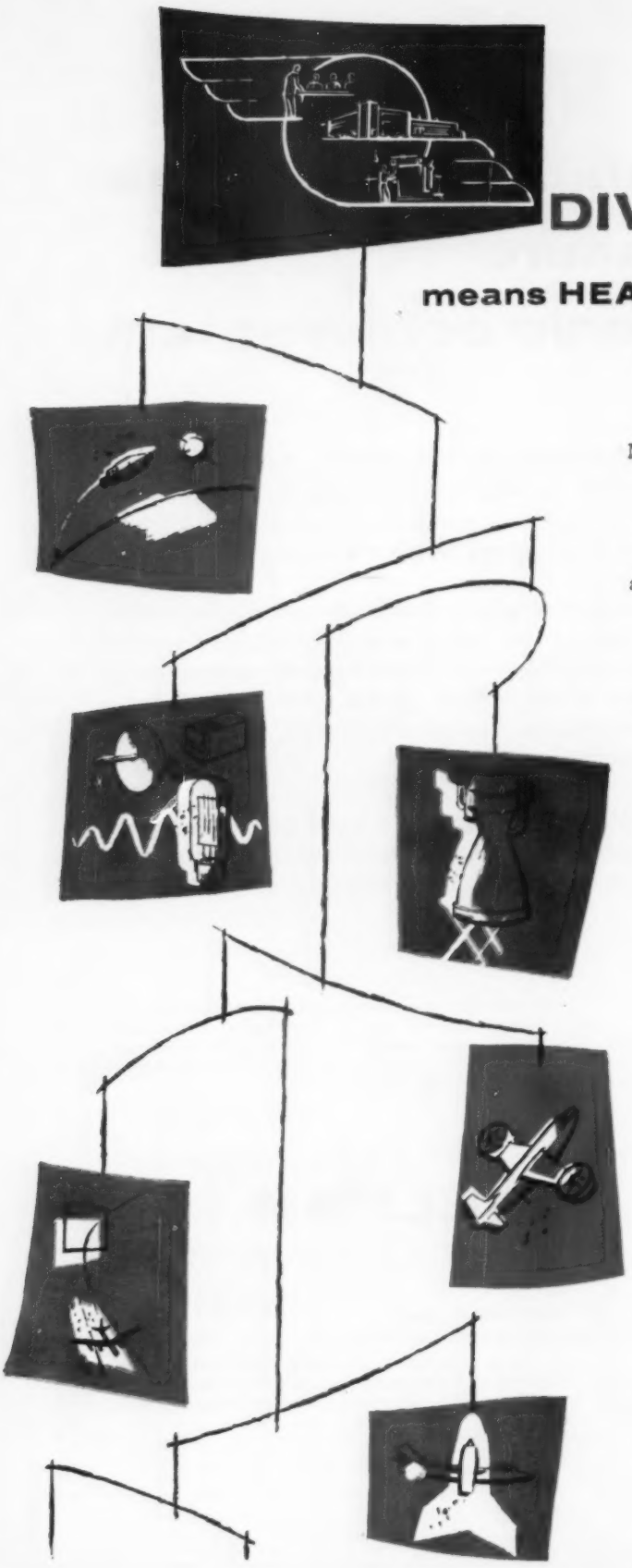

DIVERSIFICATION

means HEALTHY BALANCE at BELL

Diversification is healthy for a defense contractor, its customers, and for the nation. Here's a brief look at today's broadly diversified activities of the Niagara Frontier Division of Bell Aircraft Corporation.

Bell rocket engines are pushing an Agena into polar orbit with each launching under the Discoverer program. The Air Force has contracted for a Bell all-weather automatic landing system already proven in thousands of actual demonstrations. Bell reaction controls are being used on the X-15 and are being readied for Mercury. Bell accelerometers make up part of the guidance systems for the Army Sergeant and other missiles. The nation's first deflected jet VTOL experimental aircraft, designed and built by Bell, has been flight tested by NASA.

Bell is also actively engaged in many other highly advanced technical projects. These, to name a few, embrace such fields as double-wall construction, automatic drone control, ducted propeller VTOL aircraft, ground effect vehicles, revolutionary new battlefield surveillance techniques and extremely accurate, highly sensitive complete inertial guidance systems for aircraft, missiles and space vehicles.

That is what Bell means by broad diversification within the defense industry. That is why the proven engineering and production capabilities of Bell's Niagara Frontier Division can serve you so well in so many ways.

BELL AIRCRAFT CORPORATION

Niagara Frontier Division

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- **Sylvania Electric Products, Inc.**—W. H. Adams, $10,000.
- **Temco Aircraft Corp.**—L. S. Smith, $15,000; R. A. Galer, $22,000.
- **Shell Oil Co.**—C. S. Shadle, $14,000.
- **Fairbanks-Whitney Corp.**—G. H. Drewry, $12,000; A. M. Prentiss, $9,000.
- **Ryan Aeronautical Co.**—R. L. Schlesswhol (1).
- **Westinghouse Electric Corp.**—R. B. Pape, $7,000; V. Wilson, $9,000.

Fifty-six of the 100 largest defense contractors employ 251 former general or flag officers, according to a survey by the House Armed Services Investigating Subcommittee headed by Rep. Edward Hebert (D.-La.).

The following list of the number of generals or admirals employed by each of the firms, based upon questionnaires to the companies concerned, was released in the subcommittee's report on the employment of regular officers by defense contractors. The companies are listed in the order of the amount of defense business they handle, ranging from Boeing Airplane Co., which is the largest defense contractor, to Union Carbide Corp., the 84th largest defense contractor.

- **Boeing Airplane Co., 5.**
- **General Dynamics Corp., 27.**
- **General Electric Co., 7.**
- **Lockheed Aircraft Corp., 27.**
- **United Aircraft Corp., 8.**
- **North American Aviation, Inc., 8.**
- **Douglas Aircraft Co., 5.**
- **The Martin Co., 9.**
- **Hughes Aircraft Co., 5.**
- **Sperry Rand Corp., 3.**
- **Chance Vought Aircraft, Inc., 3.**
- **McDonnell Aircraft Corp., 2.**
- **International Business Machines Corp., 1.**
- **Radio Corp. of America, 15.**
- **Northrop Corp., 4.**
- **General Motors Corp., 2.**
- **Westinghouse Electric Co., 9.**
- **Republic Aviation Corp., 4.**
- **Chrysler Corp., 3.**
- **Grumman Aircraft Engineering Corp., 3.**
- **Raytheon Co., 2.**
- **Curtiss-Wright Corp., 1.**
- **Bendix Aviation Corp., 3.**
- **General Tire & Rubber Co., 11.**
- **Ford Motor Co., 1.**
- **Fairchild Engine & Airplane Corp., 5.**
- **International Telephone & Telegraph Corp., 14.**
- **Avco Corp., 6.**
- **Bell Aircraft Corp., 1.**
- **Burroughs Corp., 3.**
- **Socony Mobil Oil Co., 1.**
- **Philco Corp., 3.**
- **Thompson Ramo Wooldridge, 5.**
- **Cities Service, 1.**
- **Collins Radio Corp., 1.**
- **Hayes Aircraft Corp., 1.**
- **Olin Mathieson Chemical Corp., 1.**
- **Food Machinery & Chemical, 2.**
- **Goodyear Tire & Rubber Co., 1.**
- **Thiokol Chemical Co., 1.**
- **Newport News Shipbuilding, 2.**
- **General Precision Equipment Corp., 6.**
- **Garrett Corp., 2.**
- **Bethlehem Steel Corp., 3.**
- **Lear, Inc., 1.**
- **Sylvania Electric Products Co., 1.**
- **Rand Corp., 6.**
- **Marine Transport Lines, 1.**
- **Bath Iron Works, 1.**
- **Kaman Aircraft Corp., 1.**
- **Motorola, Inc., 1.**
- **Temco Aircraft Corp., 3.**
- **Shell Oil Co., 1.**
- **Fairbanks-Whitney, 3.**
- **Ryan Aeronautical Co., 7.**
- **Union Carbide Corp., 1.**

(1) *Not given*

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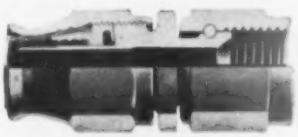

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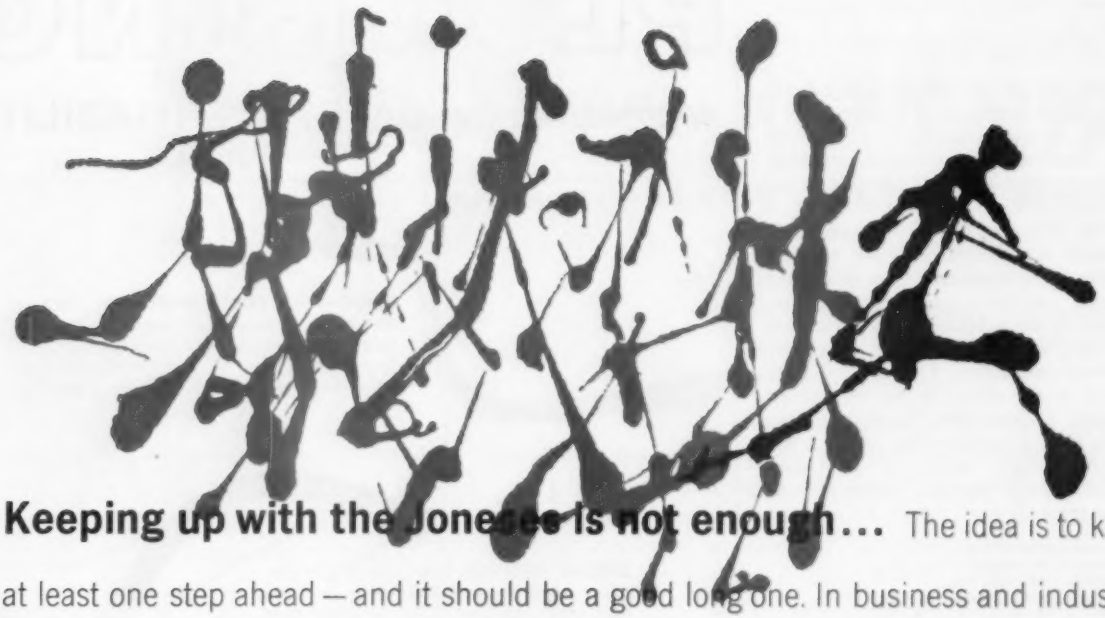

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Stock Transactions

Disposition of common shares by four officers and a director of Curtiss-Wright Corp. has been reported by the Securities and Exchange Commission for the periods from Oct. 11 to Nov. 10 and Nov. 11 to Dec. 10, 1959, as follows: James G. Byron, officer, 3,000 shares, leaving a holding of 900; Nicholas Dykstra, officer, 100 shares, leaving a holding of 100; Frank H. Hankins, Jr., officer, 200 shares, his total holding; William T. Lake, officer, 300 shares, leaving a holding of 200; Lloyd H. Smith, director, 7,100 shares, leaving a holding of 100.

Other transactions during Oct. 11-Dec. 10 include:

American Airlines, Inc. Acquisition of 400 common shares and disposition of 1,400 common shares by Samuel C. Dunlap, III, officer, leaving a holding of 1,000; disposition of 2,000 common shares, his total holdings, by Paul G. Larie, officer.

American Machine & Foundry Co. Acquisition of 2,800 common shares through exercise of option by Carter L. Burgess, officer, making a holding of 3,000; acquisition of 3,542 common shares through exercise of option by F. P. Downey, officer and director, making a holding of 8,696; acquisition of 2,936 common shares through exercise of option by Rodney C. Gott, officer and director, making a holding of 7,728; acquisition of 2,496 common shares through exercise of option by C. J. Johnson, officer, making a holding of 4,738; disposition of 300 common shares by David S. Meiklejohn, officer and director, leaving a holding of 5,300; acquisition of 5,034 common shares by Walter Bedell Smith, director, making a holding of 13,120.

Avco Corp. Disposition of 10,000 common shares by Arthur R. Kantrowitz, officer and director, leaving a holding of 6,000; disposition of 4,300 common shares by W. A. Morgensen, director, leaving a holding of 11,700; acquisition of 6,666 common shares (5,800 shares through exercise of option) by A. B. Newton, officer, making a total holding of 7,666; disposition of 3,000 common shares by Curry W. Stoup, officer, leaving a holding of 7,100.

Barnes Engineering Co. Disposition of 2,600 common shares, beneficially owned indirectly, by Dudley F. Cates, director, leaving an indirect holding of 5,000 and a direct holding of 100.

Boeing Airplane Co. Acquisition of 1,000 common shares by J. E. Prince, officer, making a holding of 2,392.

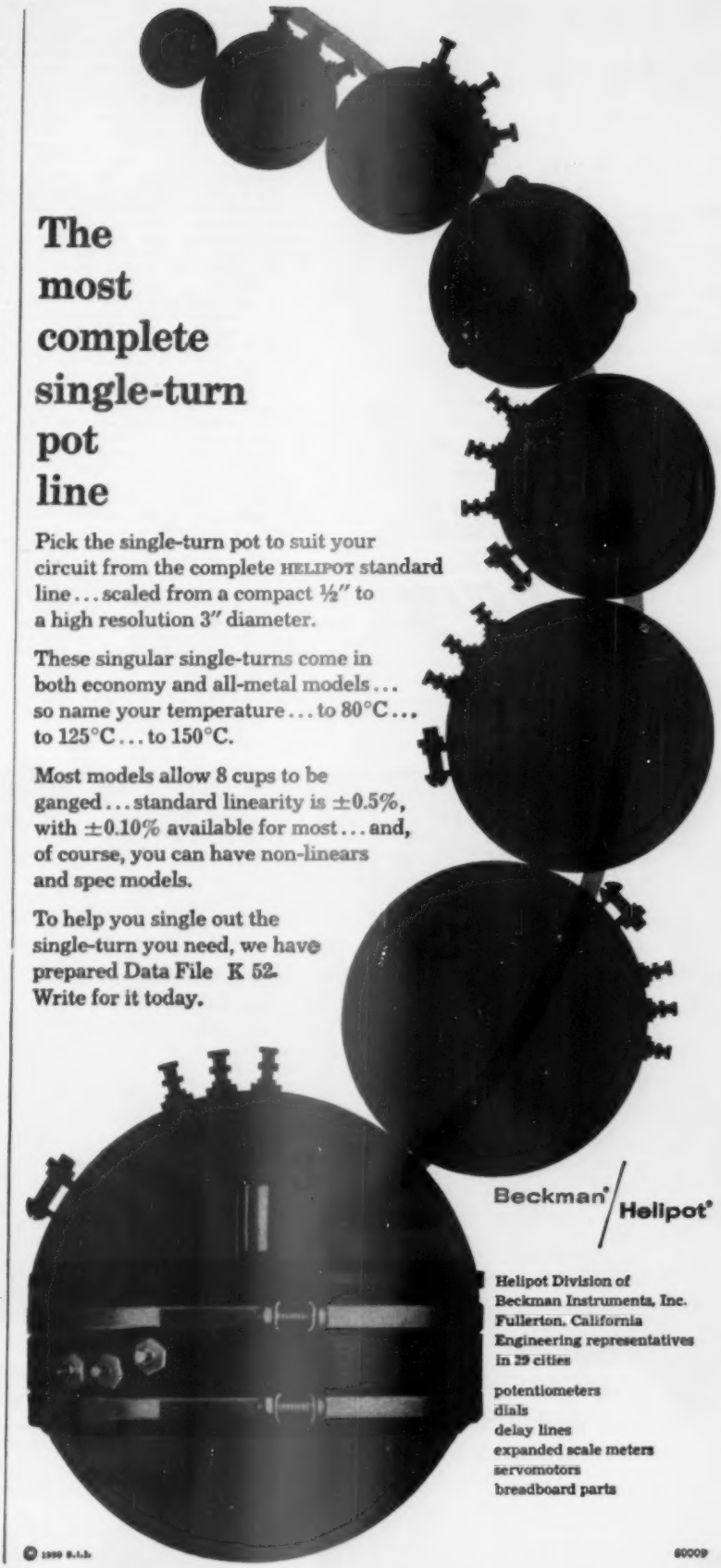
Capital Airlines, Inc. Disposition of 502 common shares, his total holding, by Stuart B. Goldthorpe, officer.

Cessna Aircraft Co. Acquisition of 200 common shares by Robert L. Lair, officer, making a holding of 300; acquisition of 500 common shares by Raymond G. Largent, director, making a holding of 1,839; acquisition of 4,000 common shares by Delbert L. Roskam, officer and director, making a holding of 9,039; disposition of 5,000 common shares by Dwane L. Wallace, officer and director, leaving a holding of 49,759.

Douglas Aircraft Co., Inc. Acquisition of 400 capital shares by Edward F. Burton, officer, making a holding of 2,905; acquisition of 200 capital shares by Luis deFlorez, director, making a holding of 600; acquisition of 137 capital shares by Stanley G. Walsh, director, making a holding of 4,000.

General Dynamics Corp. Disposition of 1,100 common shares by Lisle W. Adkins, officer, leaving a holding of 400; disposition of 1,000 common shares by Robert P. Meiklejohn, officer, leaving a holding of 2,000; acquisition of 7,550 common shares through exercise of option by J. V. Naish, officer, making a holding of 10,625; disposition of 1,000 common shares by Vernon M. Welsh, officer, leaving a holding of 10,000.

(Continued on p. 128)



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General Precision Equipment Corp. Disposition of 300 common shares by Joel Dean, director, leaving a holding of 2,100; disposition of 1,000 common shares by George T. Link, director, leaving a holding of 2,972; acquisition of 101,000 common shares by The Martin Co., beneficial owner, making a holding of 183,700; disposition of 1,335 common shares, beneficially owned by Gaylord C. Whitaker, director and beneficial owner, leaving indirect holdings of 14,855 in trusts, 355 as co-executor, 550 as guardian, and direct holding of 6,026.

Hoffman Electronics Corp. Disposition of 50,000 common shares (private transaction) by H. L. Hoffman, officer, director and beneficial owner, leaving a holding of 160,684; disposition of 5,000 common shares (private transaction) by C. E. Underwood, officer and director, leaving a holding of 10,000; disposition of 5,033 common shares by M. E. Paradise, officer, leaving a holding of 133.

Lear, Inc. Disposition of 3,618 common shares by Harold C. Andrus, officer, leaving a holding of 1,223; disposition of 1,288 common shares, his total holding, by F. D. Beamer, officer; disposition of 2,950 common shares by Roy J. Benecchi, officer and director, leaving a holding of 1,989; disposition of 625 common shares, his total holding, by Harold J. Downes, officer; disposition of 2,500 common shares by Albus Durham, officer, leaving a holding of 965; disposition of 9,000 common shares by Philip E. Golde, officer, leaving a holding of 8,104; disposition of 200 common shares by K. Robert Hahn, officer, leaving a holding of 606; acquisition of 100 common shares by A. G. Hanschumacher, officer, making a holding of 194; disposition of 618 common shares by Albert C. Keske, officer, leaving a holding of 1,441; disposition of 20,000 common shares by William P. Lear, officer and director, leaving a holding of 424,767; disposition of 6,530 common shares by Richard M. Mock, director, leaving a holding of 11,033; disposition of 500 common shares by Clarence J. Reese, director, leaving a holding of 1,000.

Litton Industries, Inc. Disposition of 1,000 common shares, as transfer of community property interest, by Roy L. Ash, officer and director, and acquisition of 12,812 common shares through exercise of option, making a direct holding of 62,611. Also: disposition of 650 common shares by Roy L. Ash, beneficial owner leaving an indirect holding of 1,450 as custodian; disposition of 95 common shares, through exercise of options by employes, and acquisition of 96 common shares, through failure of performance under contracts of sale, and disposition of 305 common shares, as transfer of community property interest, leaving an indirect holding of 5,274 in partnership. Other Litton transactions: acquisition of 400 common shares by W. Preston Corderman, officer, making a holding of 400; disposition of 2,000 common shares by David Ingalls, officer, leaving a holding of 1,153; disposition of 4,000 common shares by Myles L. Mace, officer and director, leaving a holding of 12,560; disposition of 5,113 common shares by Norman H. Moore, leaving a direct holding of 15,229, and an indirect holding of 468 as trustee; acquisition of 28,187 common shares through exercise of option and disposition of 2,000 common shares, as transfer of community property interest, by Charles B. Thornton, officer and director, leaving a direct holding of 148,550, and an indirect holding of 11,599 in partnership.

Lockheed Aircraft Corp. Acquisition of 960 capital shares through exercise of option by Herschel J. Brown, officer, making a holding of 960; acquisition of 2,400 capital shares through exercise of option by D. E. Browne, officer, making a holding of 7,154; acquisition of 1,200 capital shares through exercise of option by D. H. Cameron, officer, making a holding of 1,668; acquisition of 3,600 capital shares through exercise of option by Cyril Chappellet, officer and director, making a holding of 23,108; acquisition of 2,800 capital shares through exercise of option by Daniel J. Haughton, officer and director, making a

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holding of 6,342; acquisition of 640 capital shares through exercise of option by J. R. Janssen, officer, making a holding of 646; acquisition of 1,280 capital shares through exercise of option by Clarence L. Johnson, officer, making a holding of 1,512; disposition of 250 capital shares, his total holding, by Vernon A. Johnson, officer; acquisition of 1,600 capital shares by A. C. Kotchian, officer, making a holding of 1,600; acquisition of 1,280 capital shares through exercise of option by Burt Monesmith, officer, making a holding of 1,796; acquisition of 300 capital shares by Thomas F. Morrow, officer, making a holding of 300; acquisition of 1,280 capital shares by Leonard Eugene Root, officer, making a holding of 2,308; acquisition of 320 capital shares through exercise of option by Donald M. Wilder, officer, making a holding of 322.

North American Aviation, Inc. Disposition of 2,000 capital shares by Gerald B. Brophy, officer and director, leaving a holding of 1,734; disposition of 400 capital shares by S. K. Hoffman, officer, leaving a holding of 1,400; disposition of 2,000 capital shares by James H. Kindelberger, officer and director, leaving a holding of 10,917; disposition of 950 capital shares by R. A. Lambeth, officer and director, leaving a holding of 1,200; disposition of 2,850 capital shares by John R. Moore, officer, leaving a holding of 108; disposition of 7,500 capital shares by Raymond H. Rice, officer, leaving a holding of 237; disposition of 500 capital shares by J. Stanley Smithson, officer and director, leaving a holding of 816; disposition of 900 capital shares, his total holding, by W. H. Yahn, officer.

Pan American World Airways, Inc. Acquisition of 1,500 capital shares through exercise of option by Alvin P. Adams, officer, making a holding of 2,500; acquisition of 1,625 capital shares through exercise of option by Henry H. Berke, officer, making a holding of 3,125; acquisition of 875 capital shares through exercise of option by R. G. Ferguson, officer, making a holding of 5,547; acquisition of 3,750 capital shares through exercise of option by Franklin Gledhill, officer and director, making a holding of 5,202; acquisition of 3,750 capital shares through exercise of option by Harold E. Gray, officer, making a holding of 9,052; disposition of 200 capital shares by Roger Lewis, officer and director, leaving a holding of 2,075; acquisition of 2,625 capital shares through exercise of option by Wilbur L. Morrison, officer, making a holding of 15,312; acquisition of 1,750 capital shares through exercise of option by John S. Wodbridge, officer, making a holding of 1,750.

Raytheon Co. Disposition of 875 common shares by George Ingram, Jr., officer, leaving a holding of 1,881; disposition of 1,000 common shares by N. B. Krim, officer, leaving a holding of 2,450.

Servo Corporation of America. Acquisition of 2,500 common shares through exercise of rights and 6,500 common shares through exercise of option by Zambry P. Giddens, officer, making a holding of 9,000; disposition of 100 common shares by H. Gordon Hawthorne, officer, leaving a holding of 625.

Temco Aircraft Corp. Disposition of 1,800 common shares by D. H. Byrd, director and beneficial owner, leaving a holding of 115,260; disposition of 12,000 common shares by H. L. Howard, director, leaving a holding of 3,189.

United Air Lines, Inc. Disposition of 800 common shares by R. F. Ahrens, officer, leaving a holding of 3,736; acquisition of 1,866 common shares by Donald F. Magarrell, officer and director, making a holding of 2,032; disposition of 200 common shares by S. P. Martin, officer, leaving a holding of 1,293; disposition of 500 common shares by Charles F. McErlean, officer, leaving a holding of 980; acquisition of 768 common shares through exercise of option by D. H. Petty, officer, making a holding of 2,337; acquisition of 209 common shares through exercise of option by I. E. Sommermeyer, officer, making a holding of 761; disposition of 116 common shares by A. M. de Voursney, officer, leaving a holding of 400.

WC — **WHITTAKER CONTROLS:** Designs and produces aircraft and missile fluid control systems, subsystems and components. WC Products are in every production military aircraft and commercial airliner. In many of the nation's missile programs, Whittaker is also solving extreme fluid control problems.

WG — **WHITTAKER GYRO:** Leading designer and manufacturer of electromechanical and non-electric gyroscopes, including rate gyros vertical gyros, and position gyros. In addition, this Division is active in the sub-systems field with stable platforms, inertial guidance equipment, and autopilots for missiles.

MA — **MONROVIA AVIATION:** Producers of precision aircraft structural assemblies, Monrovia Aviation's products are installed on America's principal military and commercial jet aircraft. This Subsidiary also designs and manufactures customized portable air conditioning units for missile ground support purposes.

TS — **TELECOMPUTING SERVICES:** Skilled in the establishment and operation of data processing centers, primarily for military and civil agencies of the Government. At White Sands Missile Range, TSI processes and analyzes missile test data. At Vandenberg AFB, this Subsidiary provides data processing services for SAC's 1st Missile Division.

ES — **ELECTRONIC SYSTEMS:** Specialists in systems management, this Division also designs and manufactures a wide variety of equipment in the fields of electronics and nucleonics for highly classified Military Programs. In addition, Electronic Systems designs and produces Air Traffic Control equipment for the Federal Aviation Agency.

DI — **DATA INSTRUMENTS:** Leading designer and producer of data reduction systems for ground support and range instrumentations. Product line includes shaft rotation digital equipment, decommutators, and other highly complex and specialized instruments for missile and aircraft testing, telemetering and in-flight operation.

EC — **ELECTRONIC COMPONENTS:** Designs and produces components, including magnetic amplifiers, transformers, micro-miniature relays, delay lines and high temperature ceramic capacitors. These reliable components are being selected for installation in many of the country's principal missile and space programs.

CB — **COOK BATTERIES:** Designers and manufacturers of automatically and manually activated silver zinc batteries for specialized missile application. These auxiliary power units provide primary or secondary electrical power. This subsidiary also produces power conversion and other electronic apparatus.

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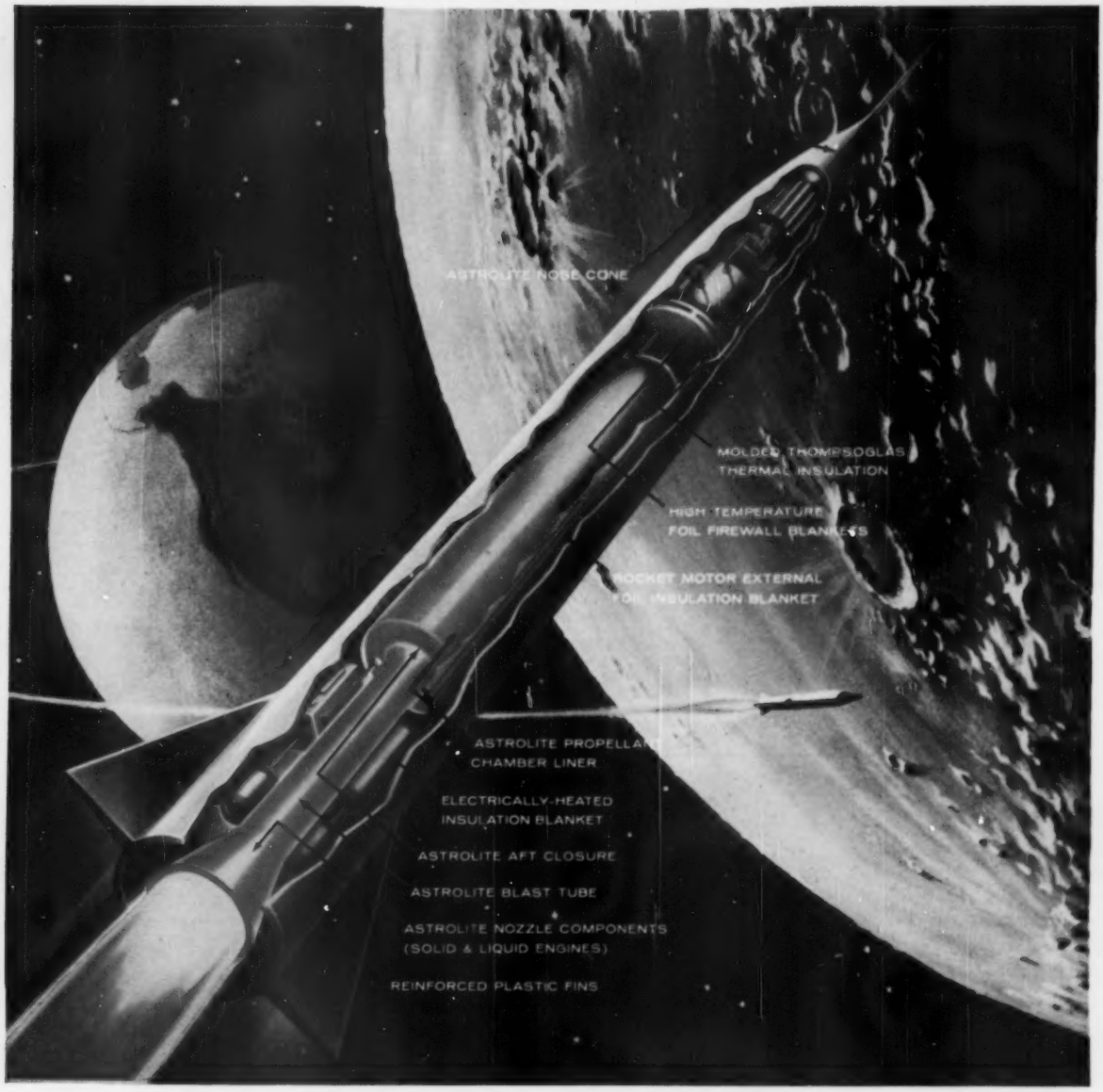
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Ship Broker Enters Aircraft Sales Field

London—Baltic Exchange, financial institution which concentrates on ship charter and bulk cargo sales, is extending aircraft operations previously confined to charters.

W. S. Shackleton, Ltd., aircraft sale and purchase brokers, has appointed a representative to the Exchange to provide sales quotations for all types of aircraft, as well as information on operating costs.

Development is calculated to ease disposal of surplus aircraft at a time when there is a big increase in the number of first-line aircraft becoming available as they are displaced by jets.

Boost in Revenues Reported by SAS

Scandinavian Airlines Systems has reported total revenues for the fiscal year ending Sept. 30 at $106.7 million, an increase of $1.2 million over the previous fiscal year.

Traffic revenue for the period was $100.3 million after deductions and commissions and other income amounted to $6.4 million. The airline also recorded regular depreciation costs of $9.9 million during the fiscal year.

SAS also reported that it carried 1,590,000 passengers, 31.68 million lb. of cargo and 13.42 million lb. of mail during the fiscal year. The airline offered 238.6 million ton-miles of space, of which 131.1 million were sold—a 4% increase over the previous fiscal year.

New Offerings

Tenney Engineering, Inc., Union, N. J., manufacturer of environmental equipment used for the simulation of climatic conditions. Offering is $500,000 of 6½% convertible debentures, due 1970, and 25,000 shares of common stock. Debentures are to be offered for public sale at 100% of principal amount with a 9% commission to the underwriters; offering price and underwriting terms for the stock to be supplied by amendment. Of the proceeds, $425,000 will be used to retire a bank loan; $125,000 to move the company's coil business from Michigan and setting up the new plant in Wilmington, N. C.; balance will be added to working capital.

Control Electronics Co., Inc., Huntington Station, N. Y., engaged in the engineering, design, development, manufacture and sale of delay lines, specialty electronic equipment, test equipment and components and filters. Offering is 165,000 shares of common stock, to be

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in heat controls

for jet windshields

Convair 880 jet airliners are first to use new, advanced design anti-fogging, anti-icing heat control systems developed by Magnetic Controls Company.

Windshield icing and fogging problems are considerably more complex for jet airliners, compared with those encountered by piston engine planes. With jet travel, faster speeds, higher altitudes, plus greater extremes in temperatures and atmospheric pressures, many new problems develop. Magnetic Controls proportional heat control systems have helped to solve these problems for Convair 880 jets. The Magnetic Controls systems offer four distinct advantages:

- **Automatic compensation for windshield aging.**
- **Ultra-reliable, fully static design.**
- **Elimination of thermal shock for longer windshield life.**
- **Superior accuracy — proportional plus integral control.**

For complete information about this system and how it may help you obtain precise, accurate heat control for many applications, write or phone Magnetic Controls Company today.

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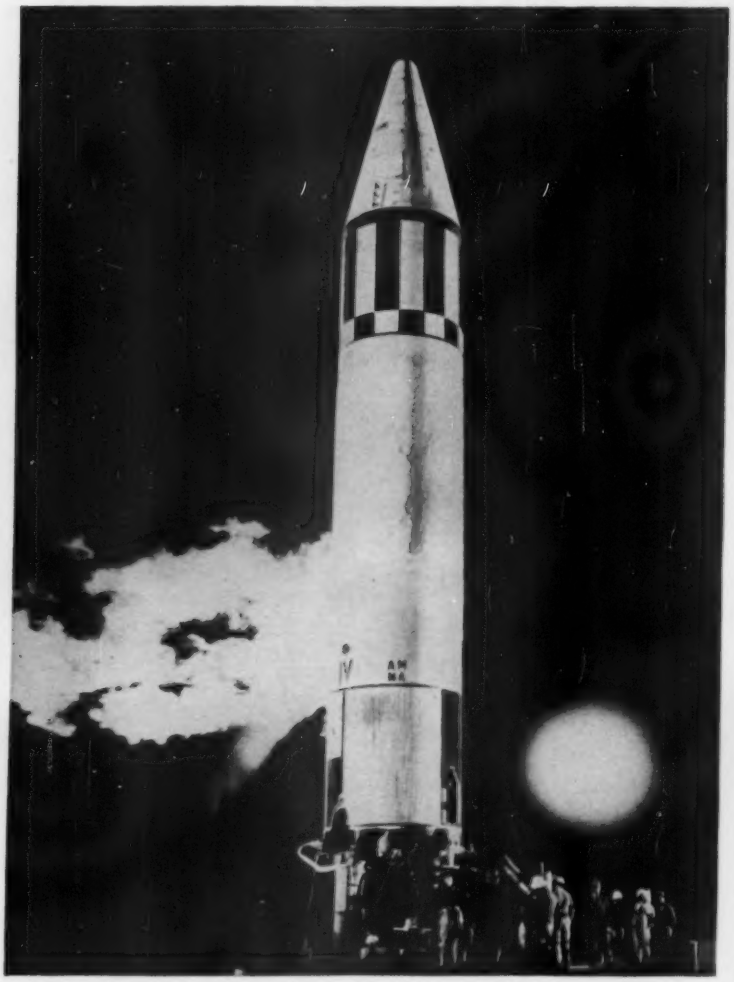
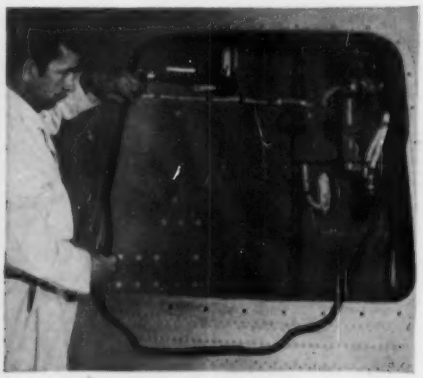
Heat Control Systems • Static Inverters • Voltage Monitoring Systems

SILICONE NEWS from Dow Corning

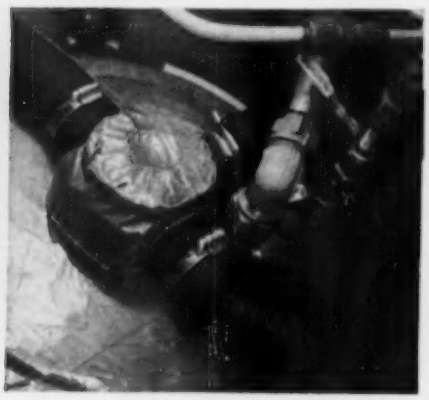
Sealing Zero...and 500 F





Silastic was specified for the Jupiter's instrument compartment access door seal. The Silastic seal has better storage properties and can better stand high skin temperatures. Wire bundle clamps in the compartment also utilize Silastic.

In the cooling system for Jupiter's instrument compartment, low pressure liquid nitrogen vapor is carried by these ducts. Made of Silastic and glass cloth, they're light in weight, and are designed to meet specs of —75 to 600 F performance.



SILASTIC SILICONE RUBBER withstands storage, cold, re-entry

Chrysler Missile Division engineers specify Silastic®, the Dow Corning silicone rubber, for flexible ducting, access door seals, and other applications on the Army-developed Jupiter IRBM.

Why Silastic? In the first place, of course, because this material has excellent resistance to extremes of temperature. From below —130 to 500 F, it remains rubbery and flexible. Re-entry temperatures far exceed 600, but Silastic survives for the brief period of time involved, whereas conventional rubber wouldn't.

Also, Silastic resists the effects of storage and weathering. Sample parts have withstood 9 years weathering at Florida test stations without measurable change of properties. This is equivalent to over 26 years of exposure under average storage conditions. Other reasons why missile designers specify Silastic include resistance to moisture, ozone, corona, many fuels and chemicals.

For further data, write dept. 0923.

Your nearest Dow Corning office is the number one source for information and technical service on silicones.

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

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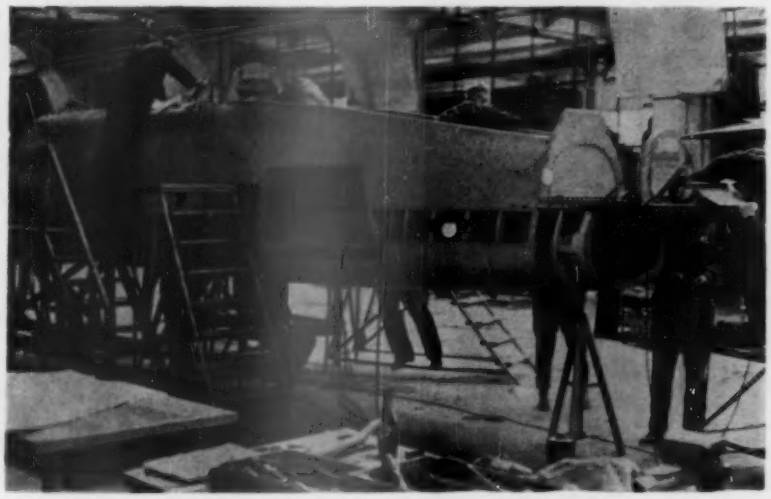
offered for public sale, at $3 per share. Underwriters will receive a commission of 36¢ per share; certain members of the underwriting firms hold an additional 15,000 common shares acquired from company officers at 10¢ per share. Proceeds will be used to repay bank loans; replace working capital expended for equipment and machinery; increase sales effort, including the organization of sales offices on the West Coast and in the Chicago areas; further development of delay lines, filters and microwave devices; balance will be added to working capital.

Sunair Electronics, Inc., Fort Lauderdale, Fla., organized in 1956, manufacturer of high-frequency, lightweight, compact radio transceivers for light executive aircraft, also toroid transformers and transistor power supply units for other manufacturing companies in the missile, communications and portable measuring equipment fields. Through subsidiaries the company is engaged in the sale of new Cessna airplanes, aircraft engines and parts, Collins radios, A.R.C. radios and other aircraft supplies and offers aircraft maintenance services, flight training and other services. Offering is 200,000 shares of common stock, to be offered for public sale at $3 per share. Proceeds will be used to purchase additional electronic and aircraft service equipment; increase inventories of Sunair and a subsidiary; construct additional aircraft storage hangars; increase ramp space; construct a new shop for electronics operation; increase working capital.

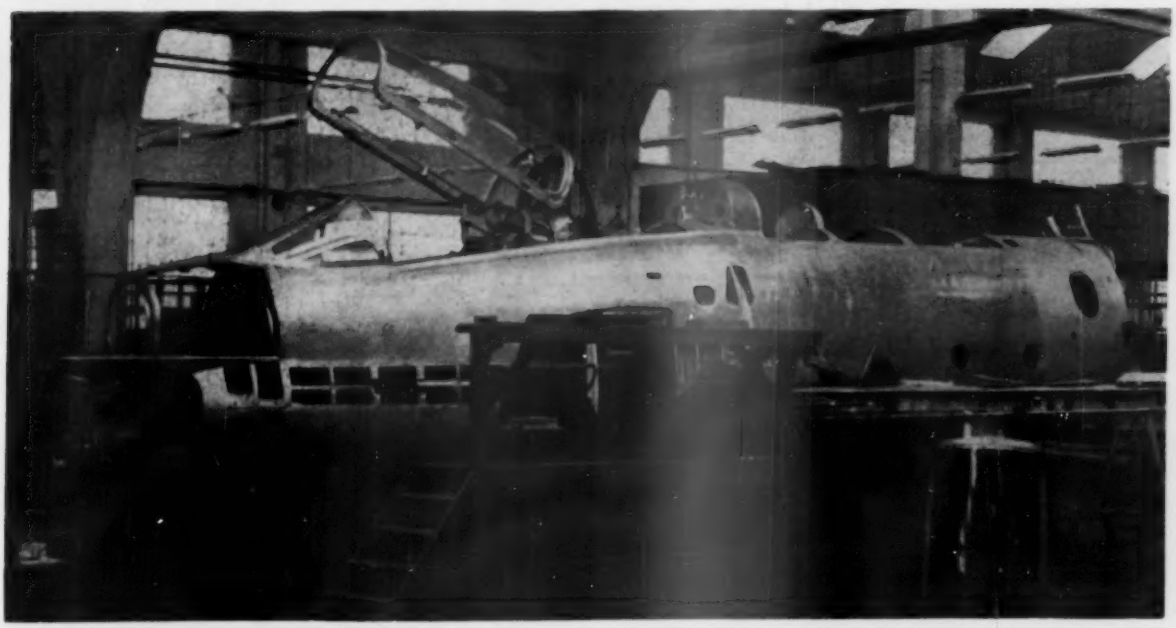
General Foam Corp., New York, N. Y., principally engaged in purchasing, processing and distributing foam rubber and synthetic foam products; company also expects to manufacture urethane and other synthetic foams. Offering is 175,000 shares of common stock for public sale at $4 per share. Majority of the proceeds will be used to finance the company's entry into the synthetic foam manufacturing business.

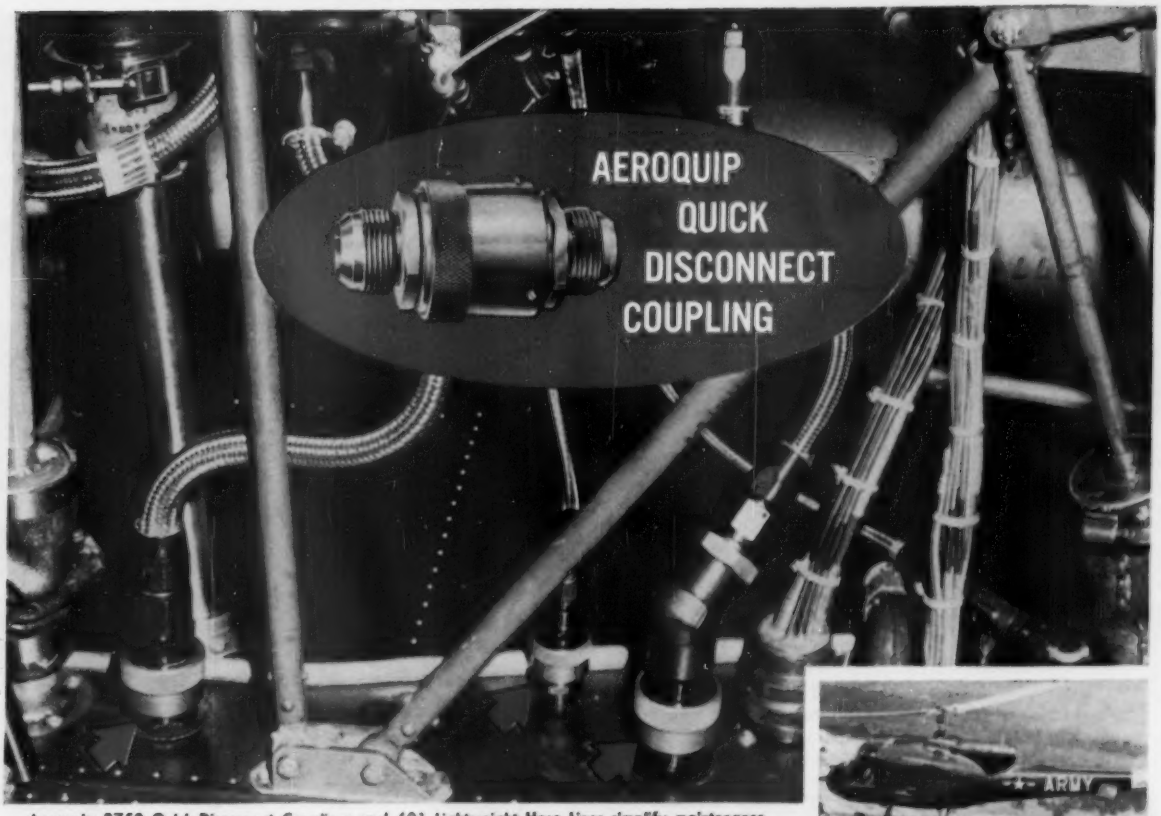
Soroban Engineering, Inc., Melbourne, Fla., engaged in the design, development and manufacture of automatic electronic computing, data processing and control equipment; it also specializes in the manufacture of electromechanical components for automation and data processing applications. Offering is 100,000 shares of Class A common stock, to be offered for public sale. Proceeds will be used for acquisition of land and erecting an additional plant; for tooling and additional equipment; for fixtures and general furnishings for the new plant; for reduction of bank indebtedness; balance to be used for general corporate purposes.



Trainer Version of Fiat G.91 Jet Fighter

Mockup of Fiat G.91T two-seat trainer version of the Italian-designed lightweight strike fighter shows the general layout of the forward fuselage (above), which has been lengthened to accommodate the extra pilot. Pilot's position was raised about 2 in. in production versions, compared with the G.91 experimental prototype, and the extra height now has been eliminated to give the rear pilot better visibility. Below is the first production G.91T at Fiat's Turin, Italy, plant. Armament installation is reduced to a single .50 cal. machine gun on each side of the fuselage and bay size is reduced accordingly.





Aeroquip 3750 Quick-Disconnect Couplings and 601 Lightweight Hose Lines simplify maintenance on the HU-1A. Marmon V-Band Coupling (upper left) also permits quick disconnection of tubing.

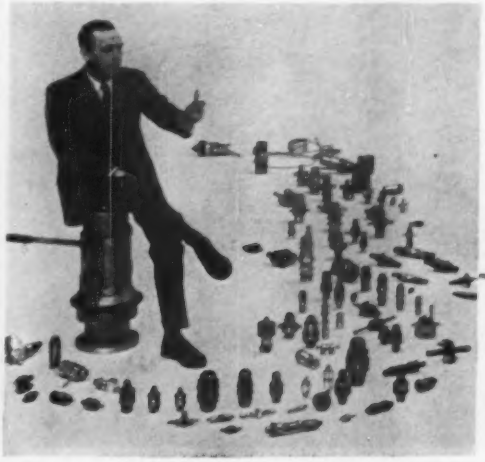
Simplifies Engine Service On Bell HU-1A

On the Army's newest helicopter, the Bell HU-1A, reliable, lightweight Aeroquip 3750 Series Quick Disconnect Couplings in sizes ¼ to ⅜" i.d., speed maintenance. Bell chose these couplings for use in the fuel, lube oil, and hydraulic systems on the HU-1A for their lightness in weight, foolproof operation, and low pressure drop. In service, they facilitate engine maintenance and removal.

These 3750 Couplings, bulkhead mounted, are coupled and uncoupled quickly with one hand. Locking indicator pins provide visual assurance of positive connection. When the pins are visible, the coupling is fully connected and locked. Inadvertent disconnection is impossible.

Aeroquip's engineering staff, the largest and most complete in its field, has developed literally hundreds of specialized quick-disconnect couplings. If you have a fluid line connection or disconnection problem, Aeroquip's unmatched experience and resources are at your service.

Fill in and mail the coupon below for information and assistance.



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NEW AVIATION PRODUCTS

Polaris Launch Valves

Automatic control valves are used in firing Polaris vehicles from submerged submarines.

One type valve is a single stage pressure regulator that provides air at constant, relatively low pressure from a high-pressure storage system. Some of this air is used to maintain proper pressure in the launch tubes prior to firing. The other valve, illustrated, regulates compressed air to control the intake of ballast water to trim the submarine when the missile is fired.

AiResearch Industrial Division, 9851 Sepulveda Blvd., Los Angeles 45, Calif.

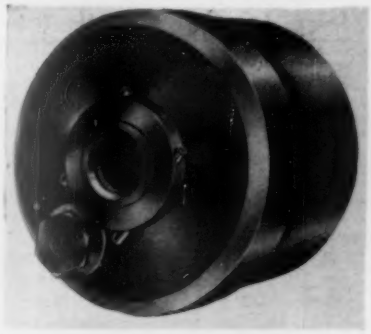
High Density Seat

Passenger seat for short-stage, high-density airline routes is designed to increase the capacity of Douglas, Lockheed and Convair piston-engine transports.

The "Commuter" series seat, avail-

able in either 6 or 9g FAA certification, weighs 9 lb. per passenger place and permits spacing to 30 or 32 in. The non-reclining seats are available in various upholstery and trim combinations.

Burns Aero Seat Co., Inc., 3900 Cohasset St., P.O. Box 127, Burbank, Calif.

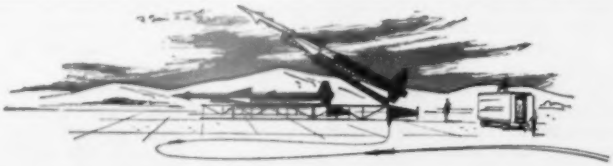


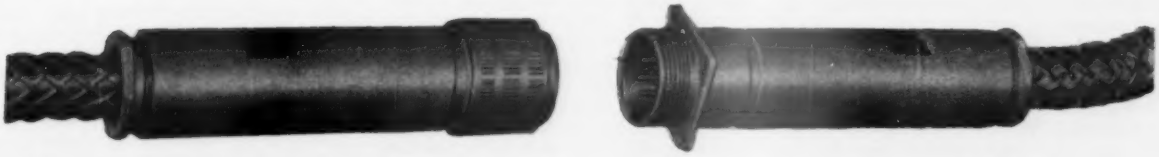
Oxygen Pressure Regulator

Oxygen pressure regulator is intended for space capsule atmosphere purging regulators or to supply constant pressure to oxygen breathing demand regulators.

The aluminum oxygen pressure regulator is piston type for reliability. The zero leakage regulator is a single stage and has a metal throttling seat. Regulator weighs 11¼ oz. and is 2¾ in. long with a diameter of 2¼ in. Pressure ranges are 100 ±10 outlet, and 100 to 10,000 inlet.

Airaterra, 620 Paula Ave., Glendale 1, Calif.





Why it pays you to specify

Bendix QWL Electrical Connectors for use with Multi-conductor Cable

For use with multi-conductor cable on missile launching, ground radar, and other equipment, the Bendix* QWL Electrical Connector meets the highest standards of design and performance.

A heavy-duty waterproof power and control connector, the QWL Series provides outstanding features: • The strength of machined bar stock aluminum with shock resistance and pressurization of resilient inserts. • The fast mating and disconnecting of a modified double stub thread. • The resistance to loosening under vibration provided by special tapered cross-section thread design. (Easily hand cleaned when contaminated with mud or sand.) • The outstanding resistance to corrosion and abrasion of an aluminum surface with the case hardening effect of Alumilite 225 anodic finish. • The firm anchoring of cable and effective waterproofing provided by the cable-compressing gland used within the cable accessory. • The watertight connector assembly assured by neoprene sealing gaskets. • The additional cable locking produced by a cable accessory designed to accommodate a Kellems stainless steel wire strain relief grip. • Prevention of inadvertent loosening insured by a left-hand accessory thread. • The high current capacity and low voltage drop of high-grade copper alloy contacts. Contact sizes 16 and 12 are closed entry design.

These are a few of the reasons it will pay you to specify the Bendix QWL electrical connector for the job that requires exceptional performance over long periods of time. *TRADEMARK

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CAB Accident Investigation Report:

Factors Leading to Electra Crash Cited

At approximately 2356 EST, on Feb. 3, 1959, an American Airlines Lockheed Electra aircraft crashed into the East River while attempting an instrument approach to Runway 22 at La Guardia Airport.

There were 73 persons on board, including one infant. The captain and one stewardess were killed; the first officer, flight engineer, and the remaining stewardess survived. Of the 68 passengers, 5 survived. To date 63 bodies have been recovered including the bodies of the captain and one stewardess; two others are still missing.

The Board believes that a premature descent below landing minimums was the result of preoccupation of the crew on particular aspects of the aircraft and its environment to the neglect of essential flight instrument references for attitude and height above the approach surface.

Contributing factors were found to be: limited experience of the crew with the aircraft type, faulty approach technique in which the autopilot was used in the heading mode to or almost to the surface, erroneous setting of the captain's altimeter, marginal weather in the approach area, possible misinterpretation of altimeter and rate of descent indicator, and sensory illusion with respect to height and attitude resulting from visual reference to the few lights existing in the approach area.

As a result of this accident, the Federal Aviation Agency, on Feb. 8, 1959, as a precautionary measure, raised Electra landing minimums. Upon the installation of the conventional three-pointer altimeter, the restrictions were lifted.

The Board has recommended to the Federal Aviation Agency that autopilot approach criteria and limitations applicable to all air carriers should be established, taking into account the particular autopilot used, the aircraft involved, and the approach facilities utilized. The Board has also recommended to the FAA that all air carriers should establish simulator training programs prior to putting into service aircraft which require the acquisition and application of significantly different operational techniques; and that all large turbine-engine aircraft used in air transportation be equipped with a flight recorder.

INVESTIGATION

Flight 320 of Feb. 3, 1959, was scheduled to depart Chicago Midway Airport at 2100[1]. It was loaded, dispatched, and operated to the New York area routinely in accordance with the applicable company and Civil Air Regulations. An instrument flight plan was filed with the company and clearance was approved by Air Route Traffic Control. The aircraft was off the ground at 2154 and estimated one hour and forty-two minutes en route to New York. Communications with the company and Air Route Traffic Control were routine.

At 2327:55, approximately one and one-half hours after departure, Flight 320 made its first transmission to La Guardia approach control. After contact was established, the flight reported it was at 9,000 ft. approaching Somerset (Pa.) intersection.

At 2328:43, Flight 320 reported over the Somerset intersection. At 2333:39, Flight 320 reported northeast bound on Amber 7 Airway and was identified by La Guardia radar. At 2334:03, Flight 320 was issued the 2331 La Guardia weather as follows: "measured four hundred overcast; a mile and a quarter visibility; light rain and fog; the visibility south and to the northwest reported at two miles; wind is southwest at three, altimeter is dropping; it is now two nine seven eight." The latest La Guardia weather was given to Flight 320 on two other occasions, at 2328:10 and at 2344:39.

During the period 2339:01 to 2349:35, Flight 320 was given heading and altitude changes to increase its separation from a preceding DC-3, and was vectored to the back course of the ILS while descending from 8,000 to 1,500 ft. The following message was transmitted to Flight 320 at 2344:39, "Roger, now the latest La Guardia weather, out at thirty-eight past the hour, the time is forty-four past the hour; it's measured four hundred overcast; two miles visibility, light rain and fog; altimeter two-nine-nine-seven. Correction, the altimeter is two-nine-seven-seven, two-nine-seven-seven, La Guardia altimeter." At 2345:43, Flight 320 was advised that another aircraft had previously missed its approach.

At 2352:23, Flight 320 reported to approach control that it had passed New Rochelle and approach control requested the flight to contact the La Guardia tower on 118.7 mc. for a straight-in approach to Runway 22[2]. At 2353:00, the flight reported to La Guardia tower as having passed New Rochelle. At 2354:37, Flight 320 reported over the La Guardia range which is 2.8 naut. mi. from the threshold of Runway 22, and 4.8 naut. mi. from New Rochelle. At 2354:40 it was cleared to continue its approach to Runway 22, and was requested to stand by for further clearance. At 2355:20, Flight 320 was cleared to land straight in on Runway 22, wind south-southwest 8 kt. At 2355:27, the flight acknowledged by saying "320." There was no further message from the flight.

The crash occurred approximately seven seconds following the final message. Most of the wreckage was found submerged within a 200-ft. radius circle, the center of which was located approximately 4,891 ft. short of the threshold and 610 ft. to the right of the extended centerline of Runway 22.

According to the testimony of the crew, the takeoff and climb from Chicago was routine. The autopilot was initially engaged sometime during climb-out in the manual mode position. Since it did not operate correctly in this position it was switched to heading mode[3] which operated satisfactorily and was used throughout the entire trip. The flight was on and off instruments at a cruising altitude of 21,000 ft.

The pitot heaters were on during the entire flight.

Some ice was encountered during descent approaching the New York area. However, it was of short duration, so the captain elected not to use the wing heaters. After passing Newark intersection, a 30 deg. error was reported by the first officer on his RMDI (radio magnetic direction indicator). However, radar vectoring and magnetic compass indications revealed the captain's RMDI was operating satisfactorily.

Landing Checks

The aircraft was flown in the New York area at an airspeed of 175 kt. or less with approach flaps. The "before landing" checklist was accomplished prior to intercepting the localizer course inbound except for landing flaps, heaters, landing lights, and autopilot which are accomplished later in the landing approach. The landing gear was extended at New Rochelle and the airspeed from New Rochelle inbound was approximately 140 kt.

The first officer stated that during the approach to La Guardia, the ILS switch was in the back course position, sensitivity switch "not desensitized," and a reciprocal heading of the front course localizer of 44 deg. was set up in the course deviation indicator window. The ADF selectors were in ADF position, the autopilot was in the heading mode, steering needle mode selector knob was in the deviation position, both VHF navigational receivers were on the La Guardia ILS, the captain's ADF was tuned to the compass locator at the middle marker (La Guardia), the first officer's to New Rochelle compass locator and, after passing that point, retuned to the La Guardia range.

The surviving flight crew members testi-

[1] All times herein are Eastern Standard based on the 24-hr. clock, shown in hours, minutes, and seconds.

[2] Initial approach procedure prescribed an altitude of 1,500 ft. asl* 10 mi. northeast of New Rochelle inbound for Runway 22, to pass New Rochelle at minimum of 1,000 ft. afl*, descend to a minimum of 800 afl over the La Guardia range station, and continue descent to 400 ft. afl altitude. If contact is established at this point, a landing may be effected. (Day and night company minimums for Runway 22 are 400 ft. and one mile.) *(asl-above sea level); afl—above field level)

[3] Heading mode is a position on the autopilot control panel that allows the autopilot to receive heading information from the captain's course deviation indicator only. If a new heading is desired, the captain need only reset the heading by rotating the heading knob. The autopilot will turn the airplane to and maintain this new heading.

Polish MD-12 Undergoes Flight Test

Polish MD-12, four-engine 20-passenger transport (AW Nov. 23, p. 23), is in the flight test stage of development. Aircraft has a useful load of 3,850 lb., cruise speed of 177 mph.

fied that during the approach, the captain was flying the aircraft by the autopilot; the first officer was handling the communications and assisted the captain; the flight engineer was handling the throttles and maintaining approximately 140 kt. on the captain's airspeed indicator.

The first officer stated he received his altimeter setting from company radio and the three crew members cross-checked the altimeters when the item was called for on the landing checklist. The flight engineer recalls the first officer resetting his altimeter after receiving a transmission from La Guardia tower. The setting was 29.77. The altimeters were cross-checked again by the first officer when passing the La Guardia range inbound at an altitude of 900 ft. Both altimeters indicated approximately the same.

Rate of Descent

The first officer stated that after passing the range station the captain momentarily increased the rate of descent to approximately 600-800 fpm. and then decreased it to about the normal rate of 200 to 300 fpm. The flight engineer also noted the captain actuate the autopilot pitch trim wheel in the "down" direction just prior to impact. The airspeed was maintained in the range of 135 to 145 kt. on the captain's instrument. There was very little throttle movement by the flight engineer; the horsepower ranged from 900 to 1,200. The first officer stated that at 600 ft. on his altimeter he called out 600 and an airspeed of 135 kt. He glanced out his right side window, saw some red lights just a little below the level of the cockpit and before he could look back to his instruments to call out "500 feet," they struck the water.

During the investigation, the first surviving crew member to be interviewed prior to the public hearing was Flight Engineer Warren E. Cook. Mr. Cook first stated the captain's drum altimeter read "between zero and the 100-foot mark on the drum" when the aircraft struck the water, and subsequently, during the same interview, clarified this statement, after being reminded that the drum reads in thousands of feet, to state the aircraft struck the water when the hand of the altimeter was on about 500 ft. as far as he could recall. Flight Engineer Cook had approximately 8,700 flying hours, 81:29 hr. of which were in Lockheed Electra aircraft, all of which were equipped with drum-type altimeters. He also had approximately 190 private pilot hours in small aircraft.

Later, the flight engineer testified that as he glanced out the captain's side window at about 600 ft. on the captain's altimeter, he observed 3 or 4 white lights and thought the aircraft was unusually low. He immediately looked at the captain's altimeter and it was indicating a little above 500 ft. when the accident occurred.

Both flight crew members stated that visual contact was never established through the forward windshield. The windshield wipers were off, the landing light retracted and off, flaps in approach position, and the autopilot was still engaged.[4] No warning lights were observed, the aircraft and engines operated normally, and there was no indication of a stall, pitch, yaw, or abrupt maneuver.

Witnesses

The surviving stewardess and four passengers stated that prior to the crash the seat belt sign and no smoking sign were "on." The stewardess had made the routine before-landing check and found that the passengers had complied with the instructions. The feeling of the survivors in the rear of the aircraft was as if a normal descent was being made for a landing.

[4] American Airlines Electra Operating Manual, Section 2, Page 34, states that: "The before landing check should be made after reporting in range. On instrument approaches, it should be completed prior to crossing range or radio fix on initial approach, or prior to leaving a holding point for final approach." The final item of the before-landing checklist is "auto-pilot off." FAA has not issued any policy directives with respect to the use of autopilots in various types of instrument approaches.

Upon striking the water, a crash impact light was observed inside the cabin. However, one of the passengers advised that he was unable to read the instructions for opening the emergency door. The stewardess advised the passenger to pull in on the door and it opened.

The crew of Northeast Airlines DC-3, Flight 383, which preceded Flight 320 by about 2 min., stated that they crossed New Rochelle at an altitude of 1,500 ft. A straight-in approach to Runway 22 was executed crossing the range at 800 ft. and then descending to 400 ft. After 10 to 15 sec. at 400 ft., the full length of the runway became visible to them and a normal descent was started and landing effected.

One ground witness in a car on the approach to Whitestone Bridge described his observations of a large aircraft crossing the highway at about 2353, at an estimated altitude of about 100 ft. He saw the whole belly and the lights on the aircraft and he stated that the markings on the aircraft were red and black. He was unable to determine whether the landing gear was down but did state that the aircraft was in a slightly nosedown attitude.

A member of the crew of the tug H. Thomas Teti, stated he saw the aircraft when it was about five to six hundred feet horizontally from the tug and about 12 ft. above the water. According to the captain of the tug, the Teti was proceeding southwesterly in the channel on radar toward the approach end of Runway 22. It was approximately 4,100 ft. from the end of Runway 22, and about 850 ft. to the left of the centerline extended of Runway 22. A crew member saw the aircraft crash and at the time he didn't notice any lights on it. He said that it contacted the water at an angle of about 5 deg. nosedown.

Weather

At the time of the accident, a low pressure center was located near Cape Hatteras and a trough extended northward from this center into the New York City area. Forecasts had underestimated the rapidity of the northward surge of warm air along the Atlantic coastal area in association with the shallow low pressure trough described above. This surge of warm air was reflected in lowered ceilings and visibilities and in the winds aloft observation at Idlewild (2/4/59, 0100 EST) which read in part as follows: Surface—southerly 6 kt.; 1,000 ft.—190 deg. 31 kt.; 8,000 ft.—190 deg. 50 kt.; 3,000 ft.—200 deg. 60 kt.

The latest weather observation at La Guardia prior to the crash was taken at 2352. At this time, the ceiling was a measured 400 ft. (variable), the sky was overcast; visibility 2 mi. in light rain and fog; temperature 37; dewpoint 35; wind south-southwest 6 kt.; and the altimeter setting was indicated as 400 variable to 300 ft. and the pressure was indicated as falling rapidly.

The crew of NEA DC-3, landing at La Guardia two minutes prior to the accident, verified the ceiling and visibility values given in the above observation.

Some members of the tug crew near the crash site, and certain ground witnesses described very restricted visibility conditions above the surface of the river and over the land areas north of the river.

The last altimeter settings for La Guardia given to the crew of Flight 320 by com-

Up, over, and beyond... this electronic eye stays on the "bird" ...without blinking

Ever try to follow the flight of a low-flying jet as it passed overhead? Near the zenith, you turned and faced the opposite direction—and searched the skies again. So fast did your quarry move, you may have lost it during the second used turning your head.

That's much the way it is with electronic trackers, too. Well known to the radar or telemetry engineer is the requirement for excessive or impossible accelerations and velocities in azimuth in order for the conventional two-axis antenna to track objects passing near the zenith. Heretofore, the standard "solution" to this problem has been to program the gain of the azimuth servo amplifier as a function of elevation angle—a procedure referred to as *secant correction* since the gain must be increased as the secant of the elevation angle.

The Canoga Model 8400 Tri-Ped, a *true* triaxial antenna designed for radar and microwave telemetry tracking, meets this problem head-on and *solves* it with a third axis called *Traverse*. For elevation tracking angles below 60°, the Traverse axis is fixed and the antenna functions conventionally. Above 60° elevation, the azimuth is locked and the Elevation and Traverse axes are used to track until the elevation angle again reaches 60° at which time the system reverts to the basic tracking mode.

Upon resumption of basic tracking the Traverse axis is restored to its zero-center position in a programmed manner. Ambiguities in azimuth data are resolved simply by reversing the sense of the readout at 90° elevation. Raw three-axis data may be used or, alternatively, the unit can be supplied with a coordinate converter whose output is the more conventional two-axis angle data.

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pany radio about one hour prior to the crash were 29.85 and plus 90, whereas at the time of the crash the altimeter setting was 29.75.

Other aircraft approaching La Guardia shortly before and after the accident did not report icing difficulties. The rapid influx of warm air aloft was causing a temperature inversion of increasing proportions.

Investigation revealed that all required airport, boundary, and runway lights at La Guardia were on.

Subsequent to the accident and in accordance with standard procedures, the FAA conducted an immediate ground check of all navigation facilities serving La Guardia. The following day these facilities were also flight checked and found to be functioning normally. The crew of the NEA DC-3, which preceded Flight 320 on the back-course ILS, reported that all facilities were operating normally.

Aircraft Structure

More than 90% of the primary structural components of the aircraft and the majority of the systems components (hydraulic, pneumatic, air-conditioning, electrical, etc.) were recovered.

The lower surfaces of N 6101A showed a general distribution of water impact damage which was somewhat more severe on the right than on the left side. Water impact broke all three landing gears rearward and tore off the landing gear doors and wing flaps. The landing gear shock strut pistons, with their wheel assemblies attached, broke away, floated, and were recovered separately. The lower forward fuselage belly was completely destroyed by the water impact and very little of it was recovered.

The fuselage shell above the floorline was broken into four general sections; the cockpit, the forward passenger cabin, the center passenger cabin, and the aft passenger cabin with the tail cone and vertical tail surfaces still attached. The left and right sides of the forward and center cabin areas were torn apart either by the impact or during recovery. The entire cabin floor was broken up into small pieces except in the extreme aft end where it was torn partially loose and buckled upward in the center. All seats were broken out of their structural attachments except in the extreme aft end of the cabin. The horizontal tail surfaces on both sides of the aircraft were broken off upward just outboard of the fuselage. The elevators remained attached to the stabilizers.

The wings were broken into four main sections. These were the two outer panels with the ailerons and outboard nacelles attached, and the two inboard nacelles with their integral wing structure and broken main landing gears. The leading edge of the right wing outboard of No. 4 engine received severe water impact damage and the wing tip was torn completely off. In contrast, the left wing outer panel only had a small area of water impact damage near the aft edge of the lower surface of the wing tip.

The wing structure between the nacelles on each side and inboard through the fuselage was completely shattered and was recovered in small pieces.

At the impact the landing gear was extended, the flaps were in approximately the

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▶ **Gerotor pumps are efficient at high altitudes and therefore are frequently specified for his service. A specialized form of internal gear pump, the Gerotor has an inner toothed element and meshing outer toothed element. The inner Gerotor has one less tooth than the outer and the missing tooth space forms a chamber for transporting the fluid from the inlet to the outlet port. (see Figure 1).**

FIG. 1

The relative motion between the inner and outer Gerotor teeth causes the oil chamber to be variable – slowly opening to maximum as it passes the inlet port – slowly closing as it passes the outlet (See Figure 2). This makes for a steady relatively pulseless flow – regardless of outside pressure changes.

FIG. 2

Thus, turbulence is minimized and foaming is avoided, efficient pumping being maintained at all altitudes.

▶ **Gerotor pumps are simple and compact in design, valveless and have high volumetric efficiency due to the fluid-tight engagement of the Gerotors which maintain high suction at high pressure. Further, this continuous contact pressure is maintained for life because of the hunting tooth principle.**

▶ Jet engine lubrication and scavenge service are common Gerotor pump applications. In addition they are frequently specified for helicopter transmissions and pumping of coolants for electronic equipment in aircraft and guided missiles.

▶ ***Technical data–is available and your inquiry is invited. Write:***

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approach position, and the right landing light was retracted. The left landing light was not recovered.

The Board has conducted an investigation of the crash injury aspects of this accident, the results of which will be the subject of a subsequent Board report.

The comparatively lengthy submersion in the East River resulted in corrosion and contamination throughout the engines, propellers, and accessories. Nevertheless, accurate determination of the condition of the parts and components prior to impact was readily accomplished.

Surviving crew members testified that all powerplants were functioning normally until the moment of impact. Detailed examination of the engines and propellers following disassembly confirmed this testimony. Engine and propeller oil systems were free of significant contaminants. There was no pre-impact damage, foreign object damage, or evidence of over-temperature. Examination of detailed parts, including bearings, accessory drives, oil pumps, and components of the reduction gear assemblies, did not show any to have failed during engine operation.

Propeller blade angles were relatively uniform and averaged approximately 36 deg. This blade angle when related to power is consistent with power readings obtained from the recovered aircraft instruments, and the crew's testimony concerning horsepower being used during the approach.

Flight Instruments

All recovered instrument and instrument system components had been submerged in salt water for periods of time ranging from about 94 hr. to 12 days. They were corroded, and many suffered from impact damage. All were inoperative with the following exceptions: the captain's horizon direction indicator, the two directional gyros, the autopilot control panel, the two static selectors, the three-axis trim indicator, the two fluxgate transmitters, and the clock on the captain's instrument panel, which was still operating at time of recovery.

The two instantaneous vertical speed indicator instrument casings were still attached to their respective panels and relatively intact, but the instrument mechanisms were missing and were not recovered. Only one instrument face was recovered.

The altimeters installed on the instrument panels of N 6101A were Kollsman, type A-28586-10-001, pressure drum type, having a range of from −2,000 ft. to 50,000 ft. altitude. The heart of this altimeter consists of two matched diaphragms which, in response to changes in atmospheric pressure, expand and contract. This expansion and contraction is transmitted to a pointer by means of a linkage and gear system. The pointer makes one revolution for each 1,000 ft. of altitude change, and two concentric drums measure the number of turns of the pointer and accordingly indicate the 1,000-ft. flight levels. Provision is made for barometric setting to correlate altitude indication with the prevailing atmospheric pressure in a manner similar to that employed in conventional three-pointer altimeters except that the numerical values of the setting appear in reverse order.

Electra N 6101A had approximately 302 hr. of flight time since manufacture during all of which the drum type altimeters installed had operated satisfactorily. Of the 302 hr. of flight time, approximately 150 hr. had been flown prior to delivery to American Airlines.

Prior to departure of Flight 320 from Chicago, the altimeters were checked by the crew and were reported operating satisfactorily; also, during the flight they appeared to be operating satisfactorily. During letdown on approach to Runway 22, both altimeters were reportedly cross-checked at 900 ft. and again at 600 ft.

The drum altimeters in N 6101A were calibrated prior to delivery by the manufacturer, Kollsman Instrument Corp., according to accepted government-industry standards. Examination and testing of these altimeters subsequent to the accident did not reveal any mechanical failures other than those attributable to impact, shock, and immersion in salt water. When the wreckage was recovered, the captain's altimeter read −1,500 ft., with a pressure altitude setting of +85 ft. (barometric setting 29.83 in.). The first officer's altimeter read −1,650 ft., with a barometric setting of 29.79 in.

Chemical analysis of the contents of the casings of the captain's and the first officer's altimeters disclosed the presence of hydrated aluminum oxide and sea water, with traces of iron and other metallic elements ordinarily found in sea water. No marks were found on the altimeter faces that could have been caused by impact of the pointers. The glass coverings of the faces of the two altimeters were in place and not broken.

Before opening the casings of the altimeters for examination of their internal mechanisms, it was found that the manufacturer's lead seal, which entirely covers the head of one of the screws that secures the casing on the altimeter, was missing from the captain's altimeter. The purpose of this seal is to determine, when an instrument has been returned to the manufacturer with a complaint, for overhauling, or adjustment, whether the altimeter had been opened since its delivery to the purchaser.

Internal inspection of the altimeters revealed considerable corrosion within each of the instruments. A broken link pin was found in the captain's altimeter and a rocking shaft pivot was found broken in the first officer's altimeter. The corrosion was removed to permit a detailed inspection of the moving parts. The broken components were replaced, after which both instruments were checked for mechanical freedom and were found to operate without significant restriction over a range of −1,000 ft. to 12,000 ft.

Calibration Curve

Since the diaphragms of both altimeters were overstressed due to submersion, it was impossible to establish a calibration curve which would be representative of the calibration of the altimeter before the crash.

Two separate static systems supply barometric pressure to the captain's and first officer's flight instruments, respectively. A third (alternate) static system is also provided as an emergency source of pressure to which either or both sets of flight instruments may be connected by means of static system selectors.

The captain's and the first officer's static selectors were found in normal positions;

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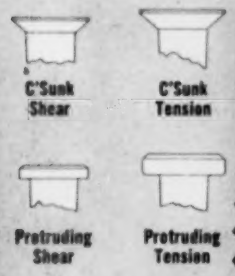

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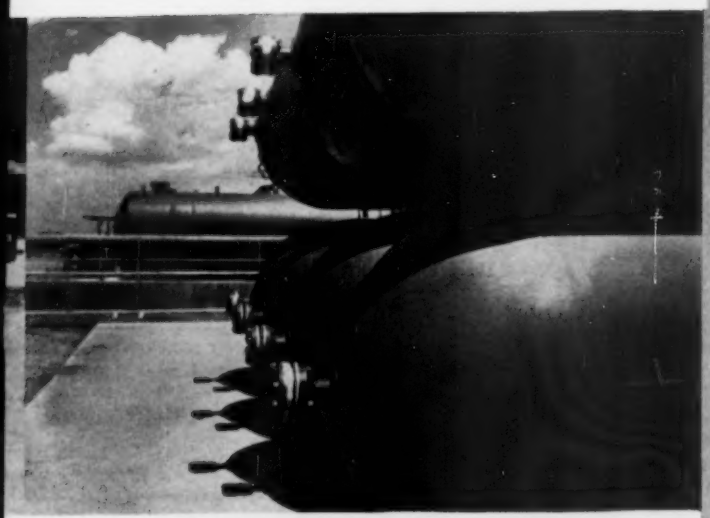
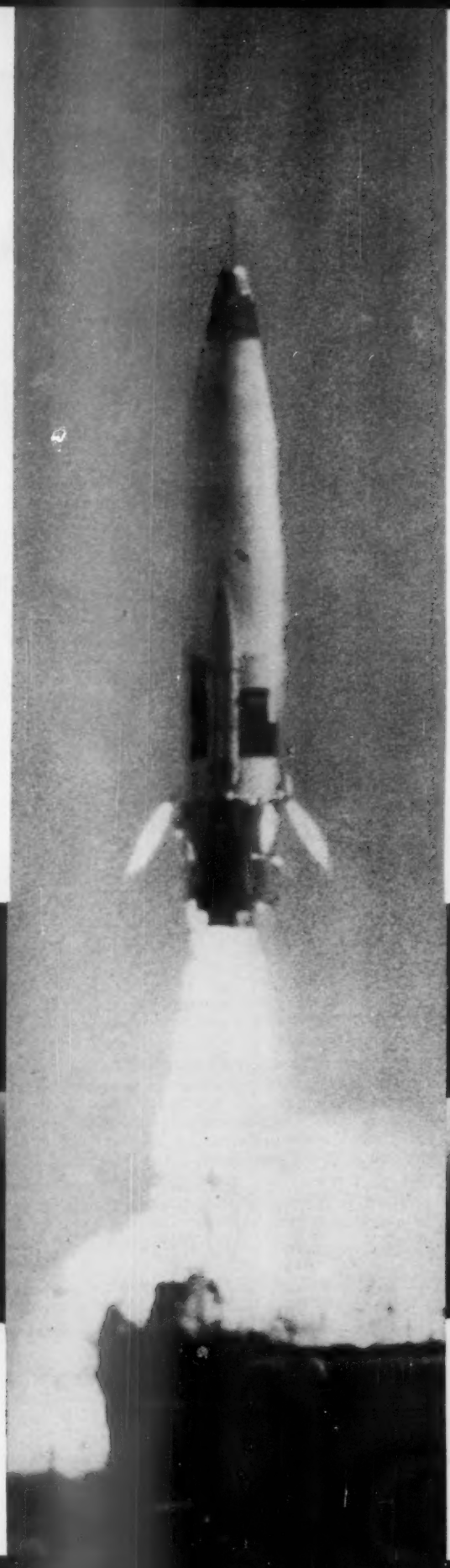
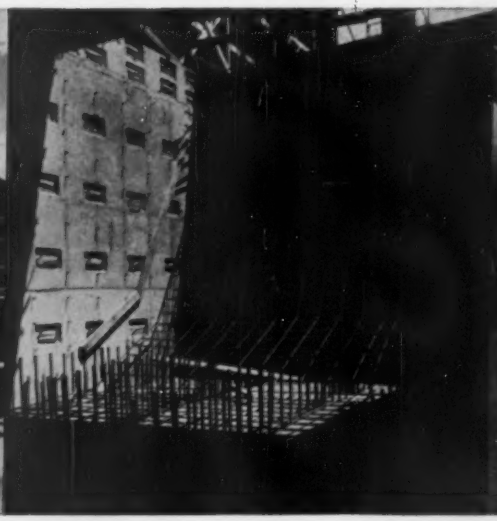




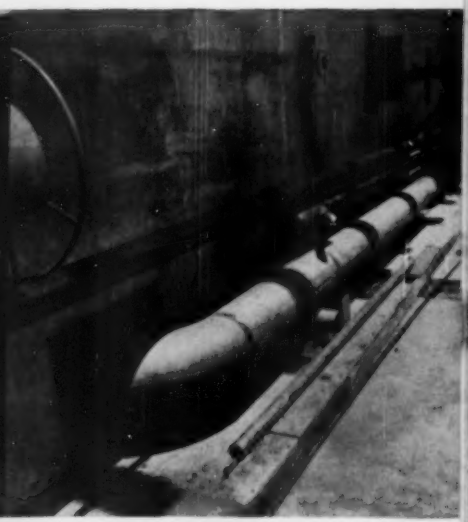
The Atlas is powered by a cluster of liquid propellant rocket engines that burn liquid oxygen and RP-1, a kerosene-like hydrocarbon fuel. 192 pressure tanks fabricated from alloy or Stainless Steel plate at this site store liquid and gases—liquid oxygen and nitrogen and helium gases which are used to inject the fuels into the missiles.

Somewhere east of Laramie, on one of Wyoming's plains, you'll find the strangest government housing project ever built. Six concrete and steel buildings are being constructed to house Atlas missiles. The site is one of the operational intercontinental missile bases to be operated by the Strategic Air Command. This base is being constructed on the surface. Follow-on bases will burrow deep into the earth. In all these systems, the Air Force puts much emphasis into ground support equipment. Virtually all steels required can be purchased from one firm — United States Steel. Whether it's carbon

The U. S. Army Corps of Engineers is constructing this operational intercontinental missile base in Wyoming. In front of the partially completed Launch and Service Buildings are Col. Sidney T. Martin, in charge of construction, and Maurice K. Graber, a construction engineer for the Corps.



This is the inside of the blast pit of one of the launcher buildings. In all six of these buildings there are 1,040 tons of structural steel, 1,950 tons of reinforcing steel, over 48,000 tons of concrete aggregate, blocks and cement, and 8,040 tons of mechanical steel items.



Fuel lines and process piping are Stainless Steel and operate at pressures up to 15,000 psi. The pipes are kept almost surgically clean to prevent contamination of fuel and subsequent malfunction. Vapor degreasing and chemical cleaning processes are used on the pipes.

both were guarded and operable. All connections to the static manifold and from the manifold to the static selectors were proper. The flex-hose assemblies from the static selector valves were properly connected with the aircraft piping.

Simulated icing tests were arranged by the Board and run subsequent to the accident using a B-29 Air Force icing tanker, a test Electra, and a chase Electra for photographic purposes. Flight tests duplicated airplane speeds, configurations, and outside air temperatures, which existed during the final approach of Flight 320 to La Guardia. The tests showed that ice buildup on the fuselage was confined to the forward section and did not approach the area of the static ports, even when the test airplane was yawed drastically.

Ground tests on an Electra fuselage section which included the static ports were run to simulate careless washing, splashing of a fluid solvent on a cold fuselage, and a leak in the nose wheel well. These tests did not induce any significant instrument errors. Under the most drastic test, that of a suction induced by twin hemispheres in the vicinity of both static ports on opposite sides of the aircraft, the altimeter error was approximately 175 ft. at an airspeed of 135 kt. It is important to note that this venturi effect was man-made and, so far as is known, is not reproducible naturally.

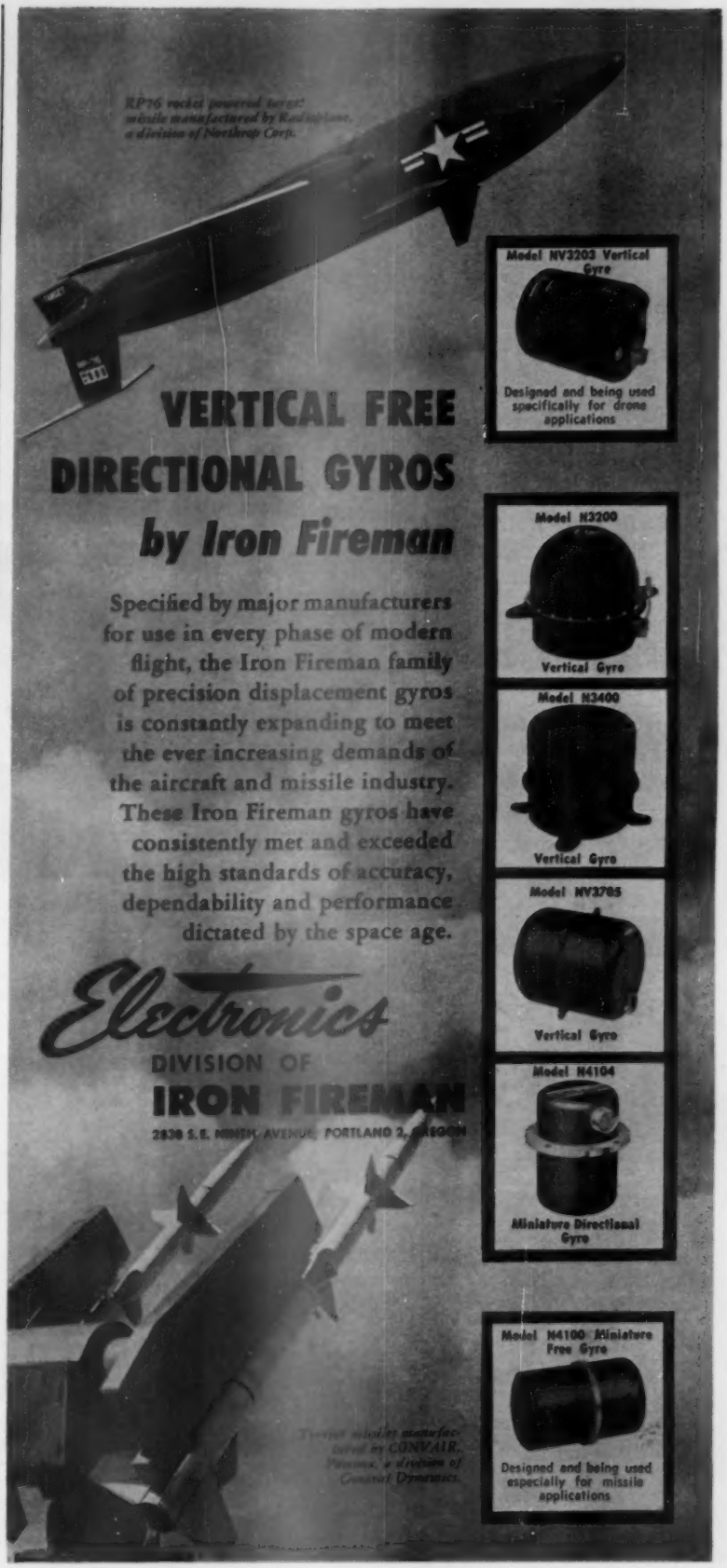
The maintenance records for American Airlines, N 6101A, were reviewed and it was found that they were complete and showed that the required maintenance had been performed, that the complaint entries of an airworthiness nature were corrected, and that they were properly signed off. The aircraft had been flown a total of approximately 302 hr.

Training

Capt. DeWitt's Electra ground school training was completed on Dec. 4, 1958, at Fort Worth, Tex. The course consisted of 84:30 hr. of instruction, of which 68:30 hr. was devoted to aircraft systems and 16 hr. to operations and performance.

An Electra simulator was not available but Capt. DeWitt did receive training in a Link trainer equipped with the flight director system similar to that installed in the Electra but not having drum-type altimeters or instantaneous vertical speed indicators. According to American Airlines' records, Capt. DeWitt, during December, 1958, completed five hours of Link training utilizing the flight director system.

Capt. DeWitt's flight training in Electras commenced Dec. 11, 1958. This consisted of day and night takeoffs and landings, airwork, autopilot operation, emergency procedures, and systems operation. On Dec. 15, 1958, Capt. DeWitt took his first type rating flight check with an FAA inspector after 8:07 hr. of Electra training. This check consisted of required maneuvers and navigational problems, holding at a fix, two-engine out ILS approaches, crosswind takeoffs and landings, and circling approaches simulating 400 ft. and one mile visibility. Capt. DeWitt failed the portion of the check which required him to perform an ILS approach simulating a 200-ft. ceiling and one-half mile visibility with engine Nos. 1 and 2 reduced to zero thrust. After additional practice, Capt. DeWitt on Dec. 16, 1958, with a total of 11:59 hr. of Electra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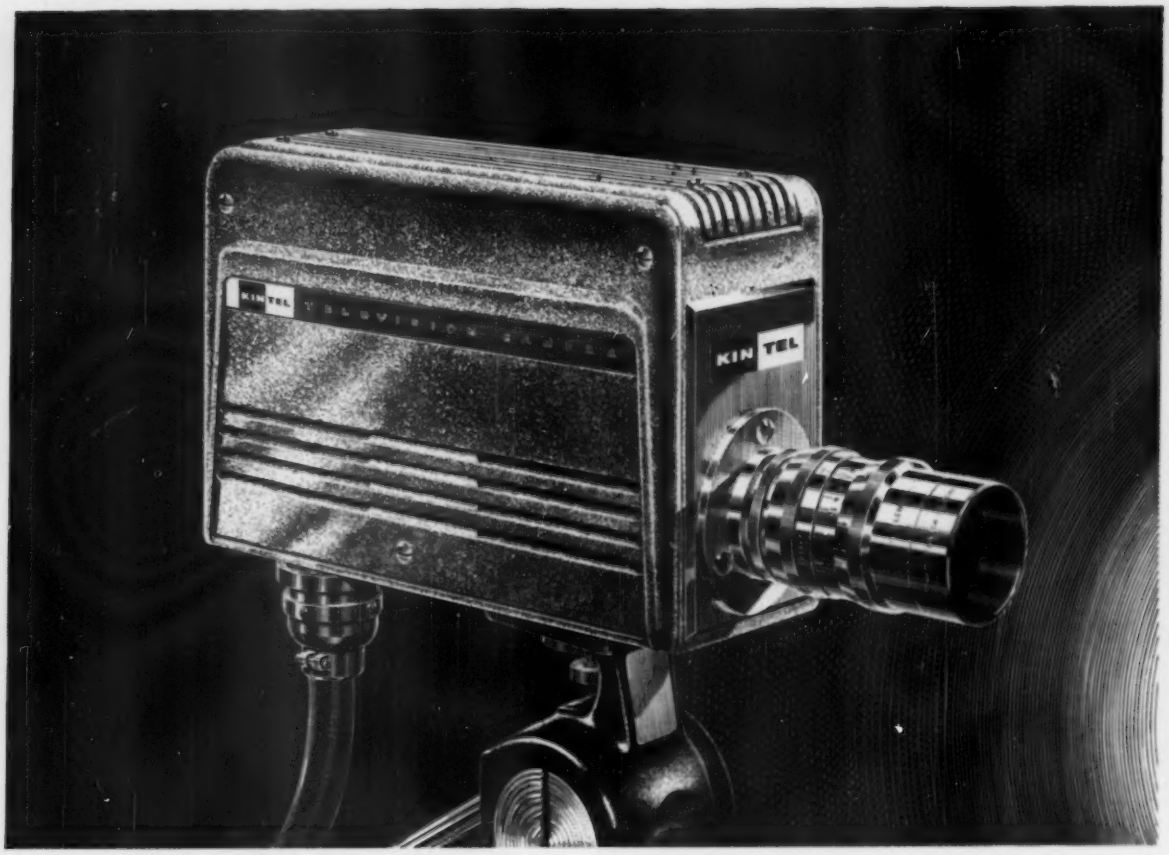

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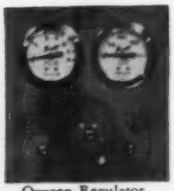

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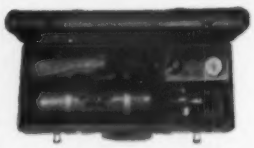

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training, successfully passed his type rating check and an instrument check.

Capt. DeWitt had acquired a total of 48:13 hr. in Electra aircraft at the time of the accident. After completion of Electra transition training, he also flew approximately 14 hr. in DC-6 and DC-7 aircraft before being assigned to Electra line operations on Jan. 25, 1959.

The American Airlines Flight Manual requires the ceiling and visibility landing minimums prescribed in the Operations Specifications—Airports, to be increased by 100-ft. ceiling and one-half mile visibility whenever the captain in scheduled operation has not served for 100 hr. as pilot-in-command on the equipment, or until such time as the captain is certified by his Regional Superintendent of Flying, as qualified to operate at the landing minimums prescribed. The company had check pilots ride with all captains on Electra equipment until they were qualified for lower minimums. The American Airlines' Regional Superintendent of Flying authorized the removal of these restrictions on Capt. DeWitt Jan. 25, 1959, when he had 12:32 hr. of flying the Electra in scheduled operations.

The correct procedure for making a back-course ILS approach to Runway 22 at La Guardia is outlined in the American Airlines Flight Manual carried by the pilots of N-6101A; cross the La Guardia Range at the minimum height of 800 ft. (820 above sea level) at 140 kt.; when over the center of the La Guardia Range station, commence an immediate descent while maintaining 140 kt.; level off at 400 ft., the minimum Electra ceiling for one mile visibility, and increase power to maintain level flight until the landing runway is sighted or the time to execute the missed approach procedure arrives. This is approximately one minute and 15 sec. past La Guardia Range.

Should the pilots establish visual contact with the runway at the 400-ft. minimum altitude, they may have to make final directional changes for proper runway alignment, lower flaps to landing position, lower and turn on landing lights, and descend the 400 ft. to the runway.

ANALYSIS

Testimony received by the Board indicates that Capt. DeWitt had engaged the autopilot after the takeoff climb from Chicago. Since it did not operate correctly in the "manual mode" position, a malfunction which was written in the aircraft logbook, the autopilot was engaged in the "heading mode" position for the remainder of the flight, including the instrument approach.

The only other unusual events of record during the flight and prior to reaching New Rochelle were a drift off course from Amber 7 Airway before reaching the Sparkhill intersection; the discrepancy of 30 deg. in the first officer's RMDI indicator; a right turn short of the localizer centerline just prior to reaching New Rochelle; and a reported slow response by the crew to instructions from La Guardia Approach Control.

Since the flight to New York was uneventful except for the above mentioned incidents, this analysis will concentrate upon the final segment of the flight path.

The weather at La Guardia Field, the weather known to prevail in the New Rochelle-La Guardia area, and the weather reported by the flight immediately preceding Flight 320, make it highly probable that Flight 320 could not have been observed from the ground immediately prior to the range station at an altitude much above 400 ft. That this final descent had been initiated at an altitude less than the approved minimum of 820 ft. over the range station is borne out by the observations of the witnesses in the vicinity of the station. A lay or even a skilled aeronautical witness has great difficulty in estimating accurately the height of an aircraft above the ground.

Establishing Height

This is especially true when the kind and size of the aircraft is not known to the witness and familiar reference points for establishing relative size and height are neither known nor discernible. It is possible, however, to obtain a compelling impression which, while not accurate in every detail, establishes the most significant facts. In this instance the Board is of the opinion that the one known eyewitness to Flight 320 just prior to its passage over the range station actually saw it, that it was flying low, and was headed in the direction of the range station. The Board is of the opinion, however, that his estimate of 100 ft. is too low.

In fact, to have descended to an altitude below 300 ft. and successfully traversed the area without colliding with buildings or other obstacles, many of which are about 200 ft. in height along the approach path leading to Runway 22, or without having attracted the attention of many other witnesses, is highly improbable. It is believed, therefore, that Flight 320 definitely approached the range station at a height greater than 300 ft. and probably higher than 400 ft. above the ground.

If that be the case, one must return to the testimony presented by the crew, physical evidence of the wreckage, and the limitations on the possible flight paths of Flight 320 from the range station to the point of impact. All available evidence shows that Flight 320 struck the water in a very shallow descent approximately one minute after passing the range station. Furthermore, the point at which impact occurred was only two miles from the range station. In order to have passed the range station at 900 ft. and strike the water where it did, Flight 320 would have had to have experienced an average rate of at least 900 fpm. throughout its descent. During the engineering flight test of the static pressure system simulating the final approach of Flight 320 to La Guardia, it was observed that to stabilize the airspeed at 135 kt., and the rate of descent at 250 fpm., 980-1,200 hp. were required.

Operational flight tests observed by Board personnel were conducted on June 16, 1959, between the range station and the crash site using an American Airlines Lockheed Electra 188, N 6113A, which had a gross weight of 97,192 lb. at takeoff. Atmospheric conditions existing at the time were: surface temperature 63F; surface wind, northwest at 15 kt.; winds at 1,000 ft. were from 300 deg. at 16 kt.; at 2,000 ft., from 300 deg. at 21 kt. In simulating a 900-ft. descent with a constant horsepower of 900 and 1,200, descent rates up to 2,000-2,500 fpm. were reached, with airspeed indications of 175/195 kt. observed.

Such indications should normally have been immediately perceptible to the crew. If Flight 320 crossed the range station at approximately 400 ft., a rate of descent of approximately 400 fpm. would place the aircraft at the approximate impact point. Under conditions of still air such a rate of descent would be compatible with the evidence concerning the horsepower output of the engines during descent and at the time of impact since the brief period during which the aircraft was reported to have reached a rate of descent of 600-800 fpm. would require a rate of descent in the order of 200-300 fpm. during the remainder of the descent to the water.

As a result of this accident and in connection with its investigation, the Board arranged extensive tests of the altimeter systems and components of the Electra. Tests were accomplished on the effect of a possible static leak in the nose wheel well static system components; of rain and icing on the static ports; of a large spoiler ahead of the static ports; and of simulated careless washing and ground splash on the static system. The Electra static system was evaluated in flight by flying through freezing water dumped from an Air Force tanker. The results of these tests indicated ice build-up on the fuselage was confined to the forward section and did not approach the area of the static ports even when the test Electra was yawed drastically.

Inflight vibration measurements were obtained from the instrument panel and outer case areas of drum altimeters. Seven drum altimeters were then subjected to these vibrations and exercised repeatedly in a manner approximating the profile of the fatal flight and over a period of more than 500 hr. No sticking, lagging, or other malfunction was noted. In addition, one altimeter was enclosed in a transparent case which permitted examination with a strobe light in a vibration environment similar to that of the Electra instrument panel.

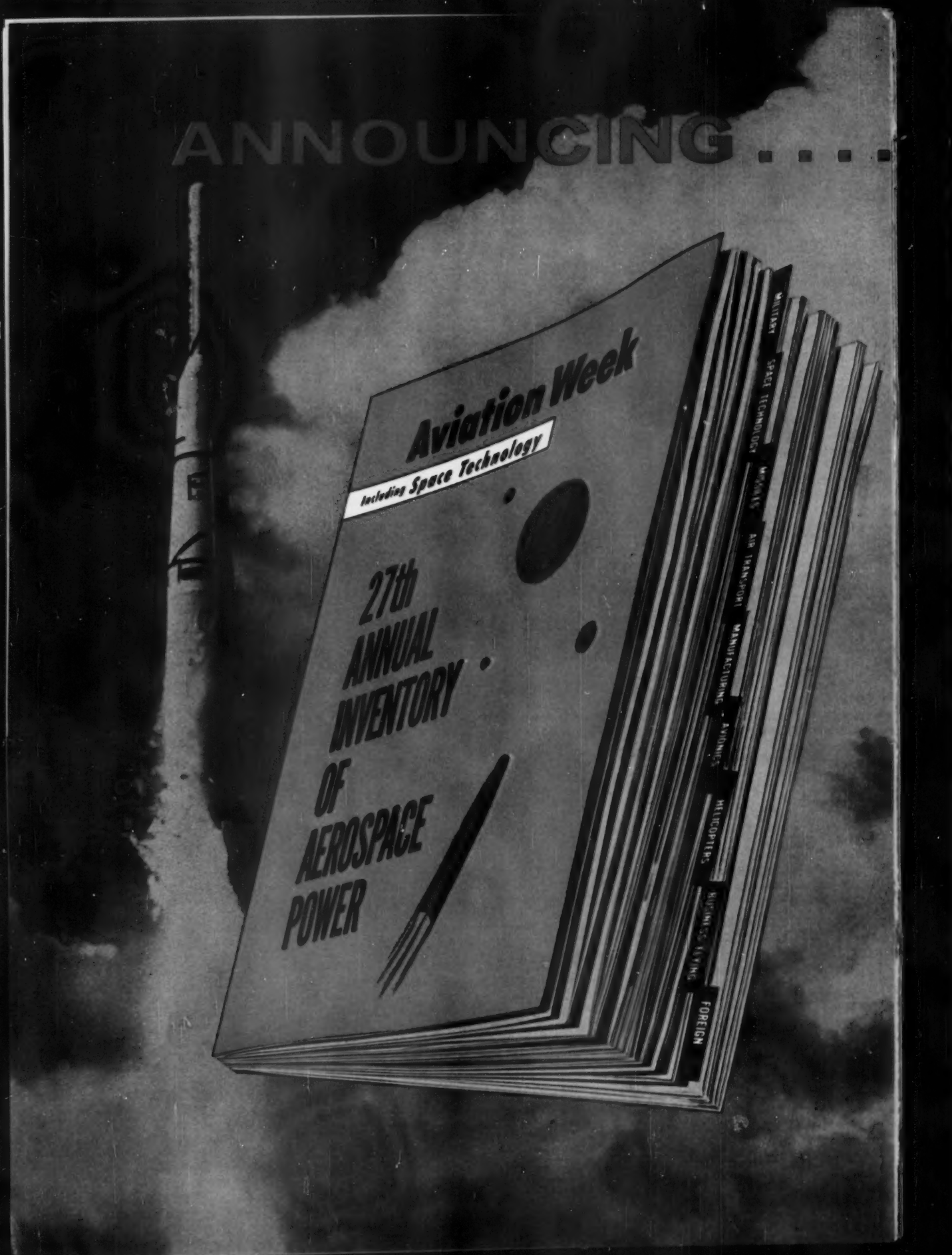
Contamination Test

Tests were conducted to measure the effect of contamination in the inlet filter screen of drum altimeters by liquids, drywing insects, and other contaminants. The effects were measured for a wide range of rates of climb and descent. The greatest error produced was 285 ft. too high during a descent at close to sea level. This was caused by completely coating the filter screen with turbo oil.

In addition to the tests arranged by the Board, tests were accomplished by Lockheed Aircraft Corp. on two groups of 10 altimeters wherein they were mounted in a test panel and exercised from ground level to 10,000 feet msl at an average rate of climb and descent of 500 fpm. The second group was moved outdoors where it was subjected to the changes in ambient temperature occurring over 24-hr. periods.

Similarly, an exhaustive review has been accomplished of all maintenance records including pilot complaints of all operators, civil and military, utilizing this type altimeter. Prior to and since this accident, several malfunctions of drum altimeters of the type installed on N 6101A have been reported. The more significant malfunctions which have occurred are described below:

On an American Airlines Electra training flight at Fort Worth, on Feb. 7, 1959, one drum altimeter reportedly stuck on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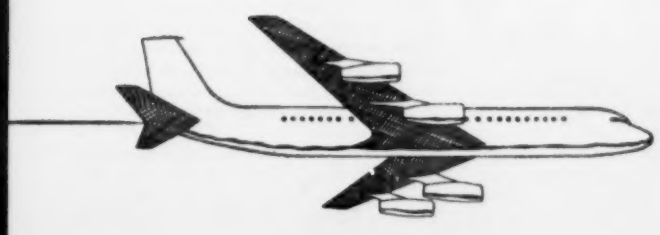

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three occasions; once at 2,350 ft., and twice at 12,320 ft. Inspection of the internal mechanism at the National Bureau of Standards laboratory disclosed that lint was adhering to the pinion teeth, removal of which permitted the instrument to function satisfactorily. The factory seal had been broken thereby preventing determination of the time lint had been introduced into the instrument.

A drum altimeter installed as a "third" altimeter on American Airlines Electra N-6107A stuck at 1,310 ft. on an ILS approach and landing at Detroit, Mich., on Apr. 3, 1959. During the removal of the instrument from the panel, the sticking ceased and the instrument indications became normal. Examination and TSO tests by Kollsman and the National Bureau of Standards disclosed this altimeter to be in satisfactory operating condition.

Of the 12 other drum-type altimeter malfunctioning reports prior to and since Feb. 3, 1959, five reported sticking above 9,000 ft.; one reported sticking (no altitude given); one read 600 ft. at any altitude (with the condition reported as being remedied by removing a kink in the connecting hose); one reported lagging and sticking due to sticky stops (no altitude given); two reported barometric pressure knobs difficult to turn because of loss of lubricant, but with no sticking in altitude readings; one read 1,000 ft. off because of being out of calibration; and one was reported as malfunctioning, but except for serial number and date, no information was given. In many instances, information supplied concerning these malfunctions was insufficient to make complete evaluations.

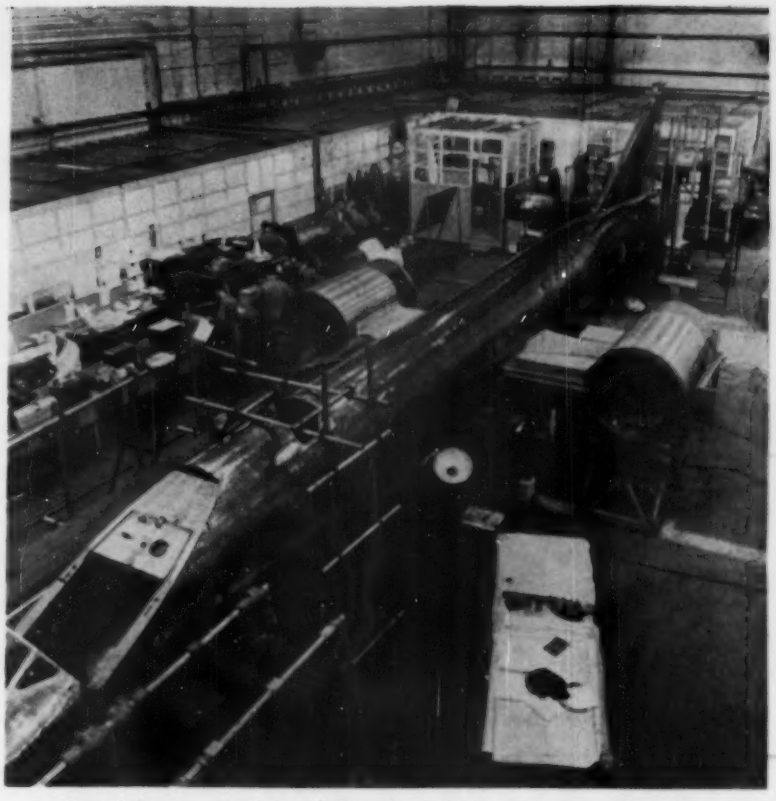
Of the drum-type altimeter malfunctions mentioned above, none of these malfunctions involved more than one of the drum-type altimeters aboard the aircraft. In addition, examination and testing of the altimeters involved in this accident failed to reveal any mechanical failure not attributable to impact shock and immersion in salt water. It should be noted that the failures causing known erroneous indications discussed earlier in this analysis could not have been detected in laboratory examination and test if the altimeters involved had been subjected to impact and submersion as were the altimeters installed on N 6101A.

The Board believes that the destruction of the two instantaneous vertical speed indicator internal mechanisms was caused by impact and submersion of the instrument panels in approximately 20 ft. of water.

Following the erroneous altitude indication of a drum altimeter at Detroit, Mich., Apr. 3, 1959, mentioned above, use of the drum-type instrument as a "third" altimeter was discontinued by all air carriers operating Electras. Since that time, the Board has had no opportunity to observe or make further critical examination of drum altimeters in Electra aircraft even as a "third" or standby instrument. However, the service results of the use of this type of altimeter in other aircraft are being monitored.

On the basis of the available evidence, several possible equipment malfunctions and operational errors have been examined critically with a view to determining the most probable cause of this accident.

As far as could be determined, the two drum-type altimeters were installed in N-6101A at the Lockheed factory. Electra N 6101A had approximately 302 hr. of flight time during all of which the altimeters had operated satisfactorily.



First Photo of Bristol Mach 3 T.188 Research Plane

First photo of the Bristol T.188 stainless steel Mach 3 research aircraft shows one of two airframes under construction at Bristol Aircraft, Ltd.'s, Filton, England, plant. Engine position (note mountings) makes high horizontal tail section necessary (AW Dec. 21, p. 22); powerplants are two de Havilland Gyron Jr. DGJ. 10 turbojets developing 14,000 lb. with afterburner. Aircraft may be used as ramjet testbed; first flight is set for next fall.

Instrument Lag

According to the testimony of First Officer Hlavacek and Flight Engineer Cook, the altimeter indications appeared normal throughout the approach to approximately 500 ft. when the aircraft struck the water. From their testimony it is apparent that any error in the two drum altimeters must have been in the nature of a lag rather than pointer sticking. Both testified to a gradual reduction in altimeter indication during the approach from New Rochelle to the point of impact consistent with descent contemplated in the instrument approach procedure. At no time were they conscious of a prolonged indication of a fixed altitude. To have indicated 500 ft. at the moment of impact, the lag in the altimeters must have been approximately 500 ft. None of the altimeter malfunctions known to the Board have involved similar manifestations.

As required by the Civil Air Regulations, the altimeters installed on the pilot's and copilot's flight instrument panels have separate static sources. The static lines leading to the instruments from normal source are completely independent. Since there exists no common element of the instruments or any of their related static system and sources, an identical and simultaneous malfunction of these instruments and associated systems of the magnitude suggested by the crew testimony would involve such an extreme mathematical improbability that the Board is compelled to reject it.

In rejecting the possibility of dual and simultaneous altimeter error the Board must, as a consequence, reject portions of the testimony of one or both flight crew members. Considering that the flight crew members received physical injuries and that they were also under great emotional stress, such questioning of their testimony has a rational basis. Under such circumstances, the Board has frequently found that the recollection, particularly of events immediately preceding an accident, is very difficult and often erroneous. Furthermore, we are mindful of the natural human tendency to assume conformance with standard operating procedures to fill in the voids or hazy areas of one's memory. On the basis of other evidence before us, the Board is compelled to reject this testimony to the extent that it would require dual and simultaneous failure of the altimeters in the order of a 500-ft. lag.

The possibility of a single altimeter failure obviously avoids most of the stumbling blocks which compelled the Board to abandon further consideration of a double

altimeter error. The absence of need for the acceptance of compounded mathematical probabilities of such extremely low order of itself facilitates this judgment. However, if we assume failure of First Officer Hlavacek's altimeter only, we are met with so many operational imponderables as to make rationalization impossible. So far as this accident is concerned, any single altimeter failure must have involved the captain's altimeter since it is clear that the captain was at the controls of the aircraft during the approach. The Board cannot conclude, however, that a single altimeter failure occurred.

Although First Officer Hlavacek had testified concerning his observation of altimeter indications down to an altitude of 600 ft., he had no recollection of a lower altitude indication. It was his impression that the impact occurred shortly following his 600-ft. observation; however, the Board believes that his subsequent judgment of this time interval may be incorrect. While approaching an altitude of 500 ft. it would have been expected that, in addition to monitoring the instrument panel, Mr. Hlavacek would be scanning the approach area for lights and handling radio communications. Considering the sparseness of lights on the approach over the East River, there could well have been greater concentration or attention than is usual since it is always difficult at night to judge attitude and altitude over the water.[5]

While the aircraft was in instrument conditions, it is also not at all unlikely that the copilot was giving careful attention to the captain's efforts to maintain the localizer path, especially in view of the apparent difficulties being experienced by the captain in maintaining a precise course. Although preoccupation with this or any of the several elements of a new cockpit environment could reasonably explain the failure of Mr. Hlavacek to follow the procedure required in the Operations Manual with respect to monitoring and calling out altitude and airspeed below 600 ft., the Board believes it more likely that he was anticipating breaking out beneath the overcast and, thereafter, having seen lights on the ground or water, was focusing particularly on visual identification of the airport and was no longer monitoring the flight instruments.

At and prior to reaching 600 ft., the flight crew members are clear as to their testimony of cross-checking altimeters. If any portion of the testimony of the flight crew members is to be regarded sufficiently reliable for the purpose of this analysis, it must relate to the earlier portion of the approach. Therefore, with respect to the possibility that the captain's altimeter had failed, we are of the view that such a failure did not occur before reaching 600 ft. Although the Board has reviewed all available records concerning instrument failure, none appears to be of the nature and magnitude of that suggested here. As has already been indicated, no evidence of instrument failure was discovered in the examination of the wreckage.

The sole evidence of a malfunction of the captain's altimeter is Flight Engineer Cook's

[5] See the Board's accident investigation reports on the following: Northeast Airlines, nr. La Guardia Airport, New York, Jan. 14, 1952; Western Air Lines, San Francisco Bay, Calif., Apr. 20, 1953; American Airlines, nr. Springfield, Mo., Mar. 20, 1955.

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testimony. His observation of the captain's altimeter, after some clarification of its facial presentation, was 500 ft. at impact. This was after the first officer had called out 600 ft. He made the observation intuitively after a momentary glimpse of lights through the captain's side window which alerted him to the fact that they were extremely low.

To substantiate further a single failure on the captain's altimeter, we must assume a premature descent and discount First Officer Hlavacek's testimony that he called out 900 ft. over the La Guardia Range Station. This is necessary in order to rationalize approximately a 300-fpm. descent as testified to by him.

The captain's altimeter was set at 29.83. The actual pressure at the time of the accident was 29.75, and La Guardia tower was reporting a setting of 29.77. This error in setting of the captain's altimeter would account for 80 ft. of erroneous altimeter indication. Since an additional minus 30-to-45 ft. of error due to static air correction must be made to the captain's altimeter, one can readily rationalize an accumulative error in which the altimeter indicated from 110 to 125 ft. higher than the actual altitude near sea level.

A premature descent is substantiated by the eyewitnesses to Flight 320 just prior to and after its passage over the La Guardia Range Station. As stated earlier, the Board believes Flight 320 approached the range station at a height greater than 300 ft. and probably not much higher than 400 ft. above the ground because of the prevailing ceiling at the time.

Misreading the Altimeter

Because of the novel presentation components of the altimeter, serious consideration has been given the possibility that the pilot misread the altitude indication and thereby permitted or caused the aircraft to deviate vertically from the desired flight path. While some incidents have been reported in which a pilot had misread the 1,000-ft. scale on the small drum, no such error could conceivably be involved here. The altitude presentation below 1,000 ft. is accomplished by a pointer the indications and appearance of which are, for all practical purposes, identical to those used by the crew in other aircraft types and the interpretation of which calls for no new or different evaluations on the part of the pilot.

The reversed sensing of the altimeter setting numerals has already been mentioned. While an erroneous setting might result from this condition, the possible order of error would be very small indeed. Unlike the primary instrument flight reference which is frequently "generalized" by approximate positions of pointers or indicators, the altimeter setting scale must be read in order to permit any substantial correction to be made. Furthermore, the altimeter setting positions which were found in the altimeters installed in this airplane are very reliable indications of the settings existing at the time of the accident. The Board does not believe that the 80-ft. error resulting from the setting of the captain's instrument is chargeable to misreading of the instrument.

One other peculiarity of this instrument, however, has raised some question as to susceptibility of misinterpretation. On the right side of the instrument face a cutout is provided through which may be seen the drum which indicates 1,000-ft. levels. On both sides of this cutout there has been printed a luminous triangular shaped index against which the 1,000-ft. calibrations are read. In a darkened cockpit, the index which appears on the left side of the drum assembly cutout has at times been mistaken for the small 1,000-ft. pointer which is installed on the older altimeters.

Such an error would leave the impression that a small hand was indicating an altitude of 2,500 ft. This fact had been brought to the attention of the company prior to the accident and it had been agreed that the left index should be removed in order to prevent such a confusion; one of the company's fleet of six Electras had had this index removed at the time of the accident. The altimeters installed in the aircraft all contained indices on both sides of cutout.

Possible Confusion

The Board is of the opinion that confusion is also possible in mistaking the right index for the 100-ft. pointer. Although this may appear remote because of the distinctiveness of shape of the 1,000-ft. altitude index as compared with the 100-ft. pointer, these distinctions lose most of their significance at night, especially where hurried references to flight instruments are required in critical flight situations. If, in a hurried glance, the right index were to be mistaken for the large 100-ft. pointer, the pilot would have the impression of being at 250 ft. when, in fact, the aircraft might be considerably below this altitude.

As a part of the Electra training program, the company gave special attention to the need for training in the Bendix Flight Director System which was installed in the Electra and was otherwise new to the line pilots. The ground trainer in which the captain received approximately five hours of initial training on the Bendix Flight Director System had installed the conventional three-pointer altimeter and not the drum-type altimeter which was actually installed in the Electra.

The instantaneous vertical speed indicator installed in the Electra does not possess the lag typical of older instruments which rely solely upon a calibrated flow from the diaphragm for the initial indication of climb or descent. In this regard it can be stated that this type vertical speed indicator possesses characteristics which are definitely superior to those of older types.

In at least one respect, however, the difference in presentation must be regarded as significant so far as this accident is concerned. This instrument installed in the Electra is calibrated in such a manner that a given displacement of the needle represents a rate of climb or descent almost three times as great as that shown on former designs. For instance, were the needle of the older instrument displaced 90 deg. downward from its normally horizontal position, it would signify a rate of descent of approximately 750 fpm. This same relative position in the case of the Electra instrument would signify a rate of descent of approximately 2,300 fpm.

In this connection, it should be understood that a proficient instrument pilot typically accomplishes more than 100 visual fixations per minute while flying solely by instruments during a maneuver such as an instrument approach. Any one fixation upon a flight instrument for the purpose of establishing a particular condition of flight such as airspeed, altitude, or rate of descent is generally a small fraction of one second. For the experienced pilot, therefore, it is common to rely upon approximate pointer position rather than consciously to read the numerical indications associated with each pointer position. Such a tendency is, of course, heightened at night when precise reading of instruments is more difficult even with optimum instrument lighting. Accordingly, there is a strong suggestion that a pilot with limited exposure to this particular instrument might be led to accept an excessive rate of descent because of a general appearance of instrument indication being within a range normal for an instrument approach when using the older instrument.

A computation of the times reported over New Rochelle and the La Guardia Range Station indicates that the groundspeed of Flight 320 on the approach between these fixes was approximately 129 kt. A computation of the times reported over New Rochelle and the La Guardia Range Station by the five flights preceding Flight 320, and an analysis of the winds aloft reports at Idlewild International Airport and surrounding areas taken at 1900, Feb. 3, and 0100, Feb. 4, indicates that Flight 320 would be making its approach into a mean wind of approximately 25 kt. from about 210 deg. The indicated airspeed between New Rochelle and the La Guardia Range Station appears, therefore, to have been in the order of 150 kt. At this indicated airspeed and at the power settings which the flight crew were using, a rate of descent higher than that necessary for this portion of the approach procedure appears to be likely.

Rate of Descent

According to the testimony of the flight crew, the aircraft passed over the New Rochelle marker at 1,500 ft. The procedure called for the flight to cross the La Guardia Range Station approximately 4.8 mi. southwest at 800 ft. At 140 kt. indicated airspeed, this distance would, in a no-wind condition, require approximately 2:03 min. to traverse. Since the flight had approximately 700 ft. to descend between these two fixes, a rate of descent in the order of 350 fpm. would have sufficed. If the pilot at New Rochelle were to adjust the attitude so as to obtain an apparent 350 fpm., based upon his experience with the older vertical speed indicators, he would have realized between 700 and 1,000 fpm. The result of an excessive rate of descent would be for the airspeed to increase. The evidence of record shows that the airspeed was in fact higher than the 140 kt., to which the crew testified.

We regard it significant that the ground trainer in which the captain received initial training on the Bendix Flight Director System had installed the conventional vertical speed indicator and not the instrument which was actually installed in the Electra.

The possibility of misreading either the altimeter or the vertical speed indicator could hardly of itself satisfy the Board's search for a probable cause of the accident. There exist far too many other sources of cross-check for the pilot; moreover, the copilot has full facility for monitoring and

cross-checking through a completely independent flight instrument panel. Presumably, misinterpretation of one condition of flight should not normally result in gross displacement of aircraft position. However, preoccupation with any one other cockpit problem may set the stage for a dangerous drift from a desired flight path when a certain combination of circumstances exists, particularly when that environment includes any insidious or misleading assurances of a safe flight condition.

The Eclipse-Pioneer autopilot, model PB-20E, used by American Airlines on its Electra airplanes is designed to permit completely automatic control of the airplane from initial climb through an ILS approach. Automatic navigation and approach, and automatic altitude and pitch trim control are incorporated in the system. An automatic ILS approach utilizing the PB-20E is possible only where a glide path is suitably paired with a localizer course. Since no glide path is available, an automatic approach could not be made on the backcourse of the La Guardia ILS.

Testimony of the first officer and flight engineer indicates that Capt. DeWitt was making a "heading mode" autopilot approach and that the autopilot was still engaged at impact. In this method, the pilot uses the autopilot as an intermediate system to operate the flight controls instead of operating them directly through the control wheel and rudder pedals in the conventional manner.

The airplane is steered by selecting a desired heading on the course deviation indicator; the autopilot then directs the airplane to this heading. Capt. DeWitt had been using this procedure during the entire flight after the takeoff climb. According to testimony, he was actuating the pitch trim wheel, which is mounted in the autopilot controller on the pedestal to his right and slightly aft, with his right hand and was leaning forward in his seat to reach around the control wheel with his left hand to rotate the CDI cursor just prior to impact. Since no glide slope is available, proper altitude over fixes must be checked solely by reference to the altimeter.

The FAA-approved portion of the Electra Airplane Operating Manual contains no limitations as to the type of approach for which the autopilot may be used; nor does it establish any minimum altitude limitations for use of the autopilot. While it is recognized that the autopilot system installed in the Electra is capable of complete automatic control of descent path and direction in an ILS approach, the Electra Airplane Operating Manual specifies that the autopilot must be off before leaving a holding point for final approach.

Although Capt. DeWitt had made many actual instrument approaches to La Guardia Airport in other than Electra aircraft, and had made several simulated instrument approaches in the Electra, the Board could find no instance where he had made a previous backcourse ILS approach to La Guardia Airport in an Electra under actual instrument conditions. Records were not available to determine how much previous experience Capt. DeWitt had in making simulated or actual instrument approaches in the Electra using the "heading mode" autopilot setting.

Most of the wreckage was found within a 200-ft. radius circle, the center of which was located approximately 4,891 ft. short of the threshold and 610 ft. to the right of the extended centerline of Runway 22. It was determined that the horizon director indicator and course deviation indicator would indicate full-scale deflections if any aircraft were approximately 300 ft. to the right of the localizer centerline and approximately 5,000 ft. from the localizer shack. The lateral displacement of this aircraft from the localizer course is excessive and indicates that the pilot might not have been maintaining proper alignment with the localizer course during the latter portion of the approach. The captain's and first officer's RMDIs, when removed from the water, read 205 deg. and 219 deg., respectively. Although the heading indications of the two RMDIs reasonably agree with the instrument approach heading to be flown, neither reading is necessarily that of the aircraft heading at

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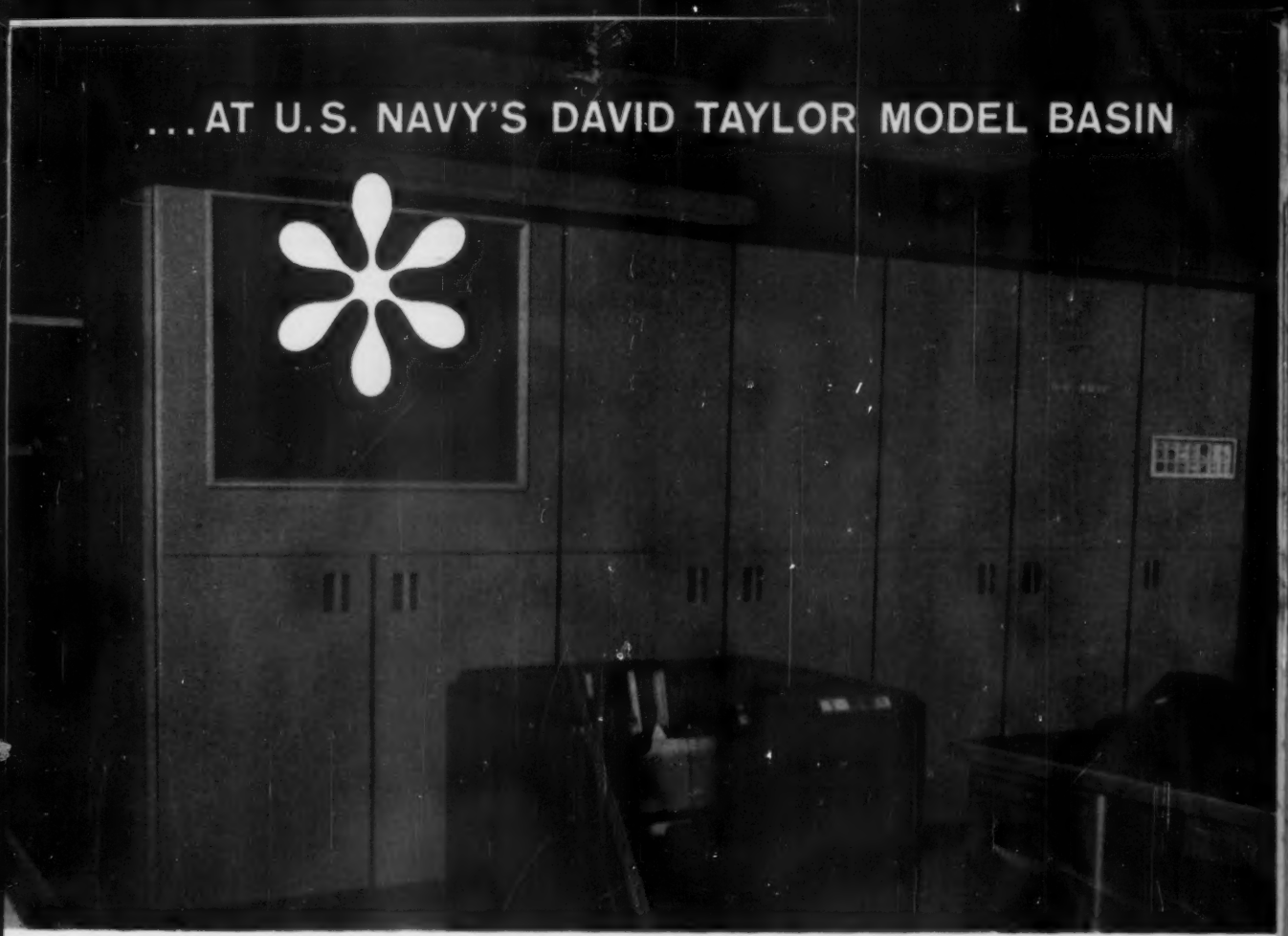

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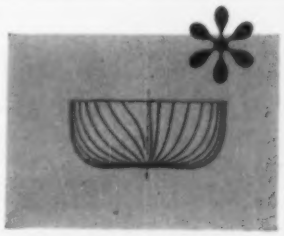

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Dassault Mirage 3A Fitted With Rocket Pods

Dassault Mirage 3A, armed with rocket pods and two bombs slung under the belly (AW July 13, p. 87), prepares for takeoff at Istres, France, test center. Rocket pods combine an armament installation with external fuel tanks; sliding band just ahead of the mounting pylon moves forward to expose vents for rocket exhaust. Pods were designed by Dassault.

impact. The effects of impact forces and the exact instant at which each of the compass systems ceased operation are unknown. In addition, the first officer's RMDI was previously found to be in error and the extent to which this malfunction influenced the final reading of that instrument is not known.

Consideration was given to the possibility that the aircraft drifted after initial impact. It was determined that the tides and currents in the channel during and following the accident were such as to have a negligible effect so far as the wreckage location is concerned. Had any drifting of wreckage occurred, it would have been in the direction which would bring it closer to the localizer centerline. The Board believes the aircraft components of substantial mass, such as the engines, sank immediately and is of the view that drift after initial impact was negligible.

ILS Localizer

Capt. DeWitt was using the ILS localizer for direction in conjunction with the ADFs to determine precisely the aircraft's position over the navigational fixes. His No. 1 ADF was tuned to the La Guardia compass locator; the No. 2 ADF was tuned to the La Guardia Range. In order for ADF information to be displayed visually on the RMDI, the selector on this instrument must be placed in the ADF position.

Investigation disclosed the selector switch for the captain's No. 1 ADF needle was selected to the ADF position; however, the No. 2 selector was in the VOR position. Under these conditions the single needle would be displaying the position of the La Guardia middle marker which is southwest of the airport and, therefore, would be approximately straight ahead of the flight throughout the final approach to the moment of impact; however, the No. 2 or double needle would be inactive, eliminating its use in displaying the position of the La Guardia Range.

Testimony also indicated difficulty in receiving the range station, although station passage was observed by the first officer on his RMDI. The No. 2 ADF control settings were 10 kc. above the La Guardia range frequency and in the loop position, this suggesting a possible manipulation of the ADF controls to confirm station passage.

Operational Specifications

Operations Specifications issued to American Airlines on Jan. 23, 1959, require that the ceiling and visibility landing minimums prescribed in the Operations Specifications be increased by 100-ft. ceiling and one-half mile visibility whenever the captain in scheduled operation has not served for 100 hr. as pilot-in-command on the equipment, or until such time as the captain is certified by his Regional Superintendent of Flying as qualified to operate at the landing minimums prescribed.

If these restrictions are to serve any purpose other than to give the appearance of a conservative flight operations policy, the Board questions the wisdom of the company in exempting Capt. DeWitt when he had but 12:32 hr. of flying the Electra in scheduled operations. This occurred nine days before the accident.

The Board has recommended that the Administrator review existing FAA policy to determine whether the waiver provision contained in the Operations Specifications should be deleted.

Operational Techniques

Another possibility of accident causation is concerned with adequacy of operational techniques.

Approaching New Rochelle and for the remainder of the instrument approach, the

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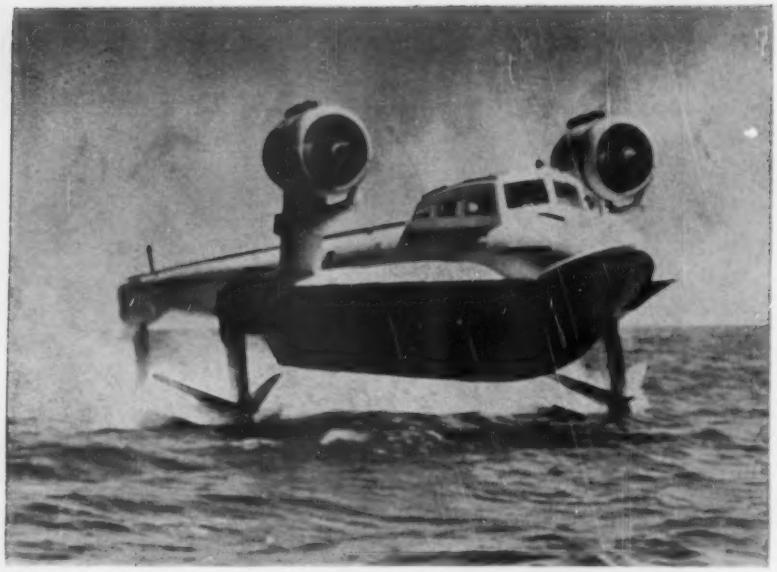


Grumman Hydrofoil Reaches 90 mph.

Grumman XCH4 hydrofoil craft, developed under Office of Naval Research contract, has attained speeds of more than 90 mph. (AW Aug. 3, p. 34). Unit shown will test various hydrofoil shapes.

aircraft was flown on autopilot in the heading mode and with the flaps in approach position. The landing gear was extended while passing over New Rochelle at 1,500 ft. and the pilot established a rate of descent which he believed to be in the order of 350 fpm. Because of the different calibration of the vertical speed indicator as compared with the instruments used by the captain during almost all of his previous 29,000 flying hours, the actual rate of descent was between 900 to 1,000 fpm. until checked by Capt. DeWitt. The captain's altimeter indicated an altitude approximately 125 ft. higher than the actual altitude.

Since the captain was utilizing the autopilot, his corrections of altitude and direction were somewhat slower than would normally be expected in a manual approach. Because of the excessive rate of descent, the aircraft descended below the minimum altitude prescribed for station passage. When crossing the La Guardia Range Station, the captain's altimeter indicated approximately 600 ft., which was slightly less than 500 ft. above sea level.

When passing the range station, the pilot lowered the nose of the aircraft to establish a rate of descent of approximately 250 fpm., inasmuch as this rate of descent, if held for 60 sec., would bring him to an indicated altitude from which a visual landing may easily have been made to Runway 22. On passing the range station, he established a descent of from 600-800 fpm. Approximately 20 sec. after passing the La Guardia Range Station the aircraft passed through an indicated 400-ft. altitude which was slightly less than 300 ft. above the water. At this time the flight engineer and first officer observed lights below the overcast. In accordance with American Airlines' Operations Specifications, Flight 320 could descend to a minimum of 350 ft. indicated altitude. Approximately 125 ft. of calibration and setting error in the captain's drum altimeter would mean the aircraft actually could have descended to 225 ft. Brief visual check on the instrument panel indicated only a very slight descent and it is possible that, expecting to find the 100-ft. pointer somewhere in the vicinity of 250 to 300 ft., he mistakenly accepted the indices on either side of the drum when, in fact, the 100-ft. pointer was already approaching approximately an indicated 125 ft. The illusion of a safe flight altitude with the limited visual reference available over sparsely lighted areas such as the Rikers Island Channel at night, is not an unknown phenomenon.[6] Furthermore, because of a dike located between the end of Runway 22 and the water of the channel, the threshold lights which are slanted at between three and five degrees would not be observed by the crew of Flight 320 unless the aircraft had been at or above the following elevations when at designated distances from Runway 22:

Distance	3-deg. Slant	5-deg. Slant
¼ mi.	79 ft.	132 ft.
½ mi.	159 ft.	265 ft.
¾ mi.	240 ft.	400 ft.
1 mi.	338 ft.	530 ft.
1¼ mi.	400 ft.	665 ft.
1½ mi.	478 ft.	798 ft.
1¾ mi.	557 ft.	929 ft.
2 mi.	637 ft.	1,062 ft.

Under these circumstances the descent continued for the few seconds remaining until impact was made by the landing gear and right wing with the water.

The reconstruction of the flight path accomplished in the foregoing paragraphs might well be adjusted for some additional altimeter error not previously indicated or disclosed during the investigation. However, we are of the view that if such an error did in fact exist it need not have been of great magnitude to permit rationalization of the factors involved.

[6] See footnote 5.

CONCLUSIONS

The Board concludes there is no one factor so outstanding as to be considered as the probable cause of this accident. On the contrary, the Board has found that the accident was an accumulation of several factors or errors, which, together, compromised the safety of the flight.

The Board believes, after exhaustive and detailed investigation, that Flight 320 flew at an average ground speed of 130 kt. between New Rochelle and the La Guardia Range Station. Using winds aloft data and time-over-fix data received from aircraft that preceded Flight 320, the Board has determined its indicated airspeed over this area to be approximately 150 kt. The aircraft passed over La Guardia Range Station at a low altitude, possibly as low as 300 ft., but probably not higher than 500 ft. The crew had limited visual reference following the range passage; the first officer and flight engineer observed lights just prior to impact. During the instrument approach, the captain's altimeter was indicating at least 80 ft., and possibly as much as 125 ft. above the altitude at which the aircraft was flying owing to calibration and setting errors.

Just prior to impact, the aircraft was in a shallow descent, in approach configuration except for landing flaps and landing light extension, and was maintaining approximately 130 kt. groundspeed. Capt. DeWitt was flying the aircraft on autopilot "heading mode" during which he was controlling altitude by manipulating the pitch trim wheel with his right hand and controlling direction by rotating the CDI cursor with his left hand. Impact occurred within seconds after the crew received and acknowledged clearance to land. The testimony of the first officer and flight engineer concerning the simultaneous misindication of both drum altimeters could not be substantiated by the evidence of record. The possibility of failure of the captain's altimeter was examined. However, the Board believes there is insufficient evidence available to substantiate this.

The Board believes that even though the accident probably resulted from the captain's neglect of certain essential instrument references, it could have been prevented had the first officer followed prescribed operating procedures, and been fully alert and attentive to all his cockpit duties throughout the approach.

As a result of this accident, the Federal Aviation Agency, on Feb. 8, 1959, as a "precautionary measure," raised Electra minimums. Upon the installation of the conventional three-pointer type sensitive altimeters, the restrictions were lifted.

During this investigation considerable testimony was presented concerning American Airlines' procedures and techniques employed in the operation of autopilots. The Federal Aviation Agency testified that it had not issued any policy directives with respect to the use of autopilots in the various possible types of instrument approaches for an air carrier.

While the Board considers that fully automatic front course ILS approaches using an autopilot coupler may be basically sound,

it is the Board's opinion that autopilot approach criteria and limitations to all air carriers should be established, taking into account the particular autopilot used, the aircraft involved, and the approach facilities utilized. Accordingly, the Board has recommended to the FAA that it initiate a study of air carrier policies, procedures, and techniques for employing an autopilot for instrument approaches and take whatever action appears appropriate.

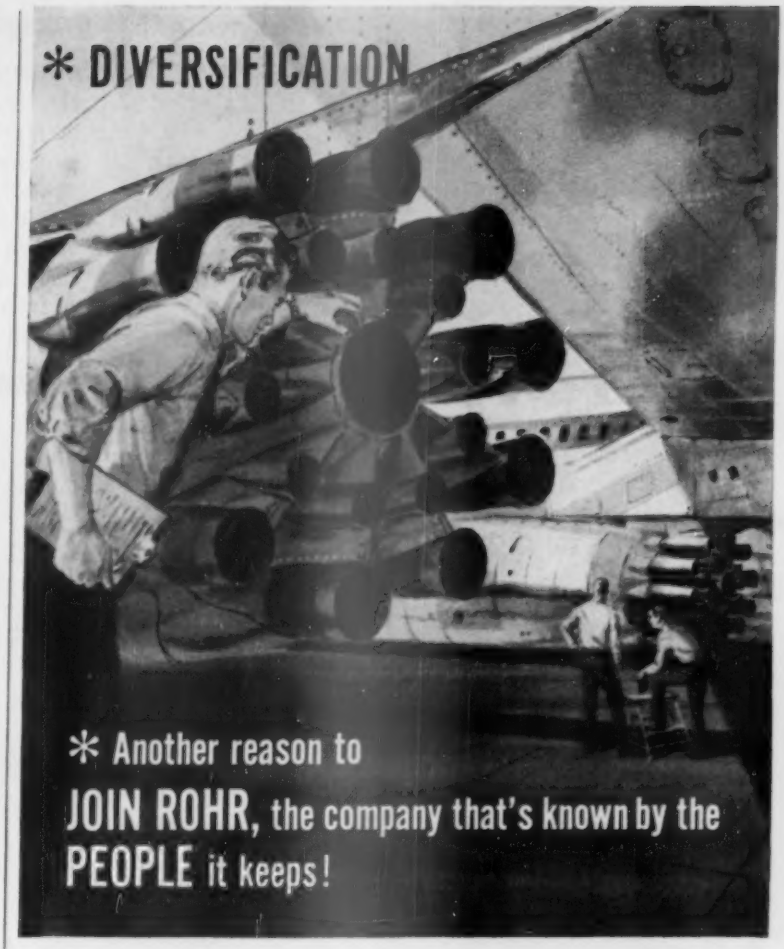
Testing New Equipment

Although, as indicated in previous sections of this report, the Board does not believe that altimeter malfunctioning was a major factor in this accident, it is convinced that the searching investigation of the altimeters as a result of this accident has disclosed the need for changes in the procedures used to approve such items of equipment and instrumentation.

Units such as the Kollsman drum altimeter, the Eclipse-Pioneer Flight Director System, and the PB-20 autopilot are approved for civil use by the Federal Aviation Agency under the Technical Standard Order System. In obtaining approval for his product under this system, a manufacturer certifies to the FAA that he has complied with all of the specifications and has conducted all of the tests contained in the appropriate TSO. This certification by the manufacturer constitutes FAA approval, and the manufacturer is free to market his product and a prospective purchaser, such as an airline, is then able to install the item in an aircraft without further substantiation of the product. Typically, FAA's TSO program does not require in-service suitability testing of items that are approved, nor does it incorporate specific quality control standards. Furthermore, evidence developed during the Board's investigation and public hearing on this accident indicated that FAA had no over-all definitive program for monitoring routine service difficulties on TSO items.

Service testing of novel designs before fleet installation is authorized would be very instrumental in uncovering design deficiencies in a product. The incorporation of specific quality control standards in the TSO and/or direct surveillance of the manufacturer's quality control organization by FAA inspectors would insure only high-quality products getting into service. Closer monitoring by the FAA of minor difficulty reports on newer TSO items would detect trends before a serious failure or malfunctioning occurred. These Board views have been conveyed to the FAA.

The Board also believes that the carrier has definite obligations in this area. In view of the novel presentation of the drum altimeters, the Board finds it difficult to understand why American did not at least incorporate this instrument in the Electra cockpit trainer used by the flight crews during their Electra training. Although this would not have been as beneficial as a more extensive preservice test evaluation of this instrument, it would at least have provided the flight crews with some experience on this important safety instrument before they used it in actual scheduled service. Similarly, the new instantaneous vertical speed indicator would have been a desirable instrument to incorporate in the cockpit trainer. In addition, added emphasis should have been placed on the difference between these new



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instruments and the older types during the crew training program until such time as it was evident that the various crews were experiencing no unusual amount of difficulty in effecting transition to the newer types.

Aircraft Simulator

The Board notes that the carrier introduced an aircraft containing the many novel systems and characteristics of the Electra without having previously established a comprehensive aircraft simulator program. The carrier has not yet procured an approved Electra simulator. Certainly there is little question that the present state of the art and the benefits to be derived from the use of simulators indicate the desirability of utilizing simulators prior to the introduction of the aircraft into air carrier service.

Whether or not any of the many factors which have been discussed in this report are of themselves critically related to this accident, we believe that their accumulative effect is significant—so significant in fact, that the extent to which they appear to compromise the safety of Electra operations must be seriously regarded. We are also of the view that almost all adverse operational aspects of new and substantially different equipment, systems, and procedures, could have been avoided through more comprehensive training in an aircraft simulator.

The Board has on previous occasions indicated its concern over the need for vigorous and comprehensive aircraft simulator programs in air carrier operations. The introduction of the Electra has increased our concern in this respect. According, we have recommended that the Federal Aviation Agency give immediate consideration to the adoption of a requirement that any air carrier planning to introduce into service an aircraft type containing equipment, systems, or characteristics significantly different from those of predecessor aircraft, shall be required to institute an approved aircraft simulator program the completion of which shall be required before any pilot may be assigned as pilot-in-command in air transportation.

Flight Recorder

In 1957 the Civil Aeronautics Board adopted an amendment to the Civil Air Regulations which required the installation of a device on certain aircraft used in air transportation for the purpose of recording continuously during flight, time, airspeed, altitude, vertical acceleration, and heading. This requirement met with considerable opposition in the aviation industry and serious consideration was given by the Board to the question whether the potential value of this device justified the cost of procurement, installation, and maintenance. The Board finally concluded that only the larger turbine-engine aircraft intended for operation in completely new environments would justify the expense of providing flight recorders. To define such aircraft types the Board relied upon a simple criterion—such recorders would be required in aircraft certificated for flight above 25,000 ft. Although the Electra is capable of flight above 25,000 ft., the carrier chose to request certification below 25,000 ft. under which limitation it is unnecessary to install flight recorders. The probability that this would be done was known to the Board at the time the regulation was written. However, the Board

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concluded that the regulation, then promulgated, represented the most demanding requirement which could be justified on the basis of the then existing state of the art.

Clearly, a flight recorder in this aircraft would have enabled us to identify the causal factors involved in this accident with far greater precision than is now possible. The Board is of the view that the quality of flight recording systems which are available to the industry warrants the conclusion that no large aircraft introduced into air carrier service should be without a recorder. Accordingly, the Board is recommending that the FAA initiate action to amend the appropriate regulations to require that all large turbine-engine aircraft used in air transportation be equipped with flight recorders.

PROBABLE CAUSE

The Board determines the probable cause of this accident was premature descent below landing minimums which was the result of preoccupation of the crew on particular aspects of the aircraft and its environment to the neglect of essential flight instrument references for attitude and height above the approach surface.

Contributing factors were:

1. Limited experience of the crew with the aircraft type.
2. Faulty approach technique in which the autopilot was used in the heading mode to or almost to the surface.
3. Erroneous setting of the captain's altimeter.
4. Marginal weather in the approach area.
5. Possible misinterpretation of altimeter and rate of descent indicator.
6. Sensory illusion with respect to height and attitude resulting from visual reference to the few lights existing in the approach area.

By the Civil Aeronautics Board:

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Chairman

Chan Gurney
Vice Chairman

G. Joseph Minetti
Member

Whitney Gillilland
Member

Alan S. Boyd
Member

SUPPLEMENTAL DATA

The Civil Aeronautics Board was notified of the accident on Feb. 4, 1959, soon after occurrence. An investigation was immediately initiated in accordance with the provisions of Title VII of the Federal Aviation Act of 1958. A public hearing was ordered by the Board and was held in New York, N. Y., Mar. 18, 1959.

American Airlines, Inc., is a Delaware corporation and maintains its principal offices in New York, N. Y. The corporation holds a current certificate of public convenience and necessity issued by the Civil Aeronautics Board to engage in the transportation of persons, property, and mail. It also possesses a valid air carrier operating certificate issued by the Federal Aviation Agency, (formerly Civil Aeronautics Administration).

Capt. Albert Hunt DeWitt, age 59, was employed by American Airlines on June 6, 1929. He held a currently effective airman certificate with airline transport and all other appropriate ratings. He had a total flying time of 28,135 hr., of which 48:13 were in Lockheed Electra aircraft. He satisfactorily passed his last FAA (formerly CAA) physical examination Oct. 16, 1958. His last semi-annual proficiency check was given by one of the company's check pilots Dec. 16, 1958.

First Officer Frank Schopen Hlavacek, age 33, was employed by the company on Jan. 29, 1951. He held a currently effective airman certificate with airline transport rating and Convair 240, 340, and 440 type ratings. He had a total of 10,192 flying hours, of which 36:35 were in Electra aircraft. His last FAA physical examination was satisfactorily passed June 7, 1958.

Flight Engineer Warren Edward Cook, age 36, was employed by the company July 28, 1948. He held a current airman certificate with flight engineer rating. He had a total of 8,700 flying hours, of which 81:29 were in Electra aircraft. His last physical examination was satisfactorily completed Nov. 7, 1958.

Stewardess Mae Markidis, age 22, was employed by the company May 7, 1957. Stewardess Joan Zeller, age 21, was employed by the company on July 29, 1958.

Electra aircraft, Model L-188, N 6101A, was manufactured Nov. 27, 1958, by Lockheed Aircraft Corp. The aircraft was equipped with four Allison 501D13 engines. The four propellers, model A6441FN-606, blades 6503368, were manufactured by Aero Products, Allison Division, General Motors Corp.

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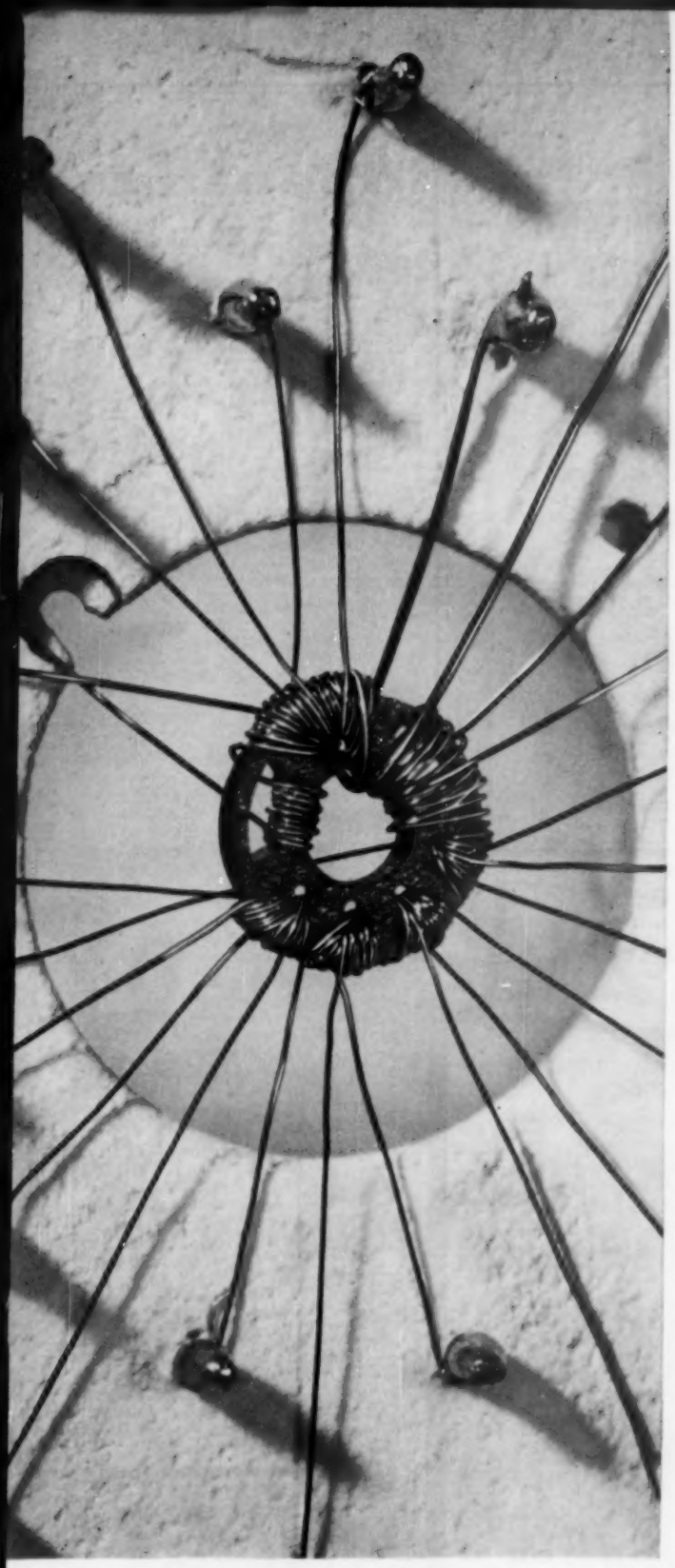

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ADVERTISERS IN THIS ISSUE

AVIATION WEEK, JANUARY 25, 1960

AEROJET GENERAL CORP. ..... 2nd Cover
AERO SUPPLY MFG. CO., INC. 139
AERONCA MANUFACTURING CORP. 86
AEROQUIP CORP. 134
AIRBORNE ACCESSORIES CORP. 6
AIRWORK CORP. 75
ALLMETAL SCREW PRODUCTS CO. 109
AMP INCORPORATED 66
ACF INDUSTRIES, INC., AVION DIV. 57
ERCO DIV. 116
ARMCO STEEL CORP. 88
ARCTURUS MANUFACTURING CORP. 91
AVCO CORP. ..... 4th Cover
AVIATION WEEK 148-149
AVION DIVISION ACF INDS. 57

BECKMAN INSTRUMENTS, INC. 126, 127
BELL AIRCRAFT CORP. 124
BENDIX ECLIPSE PIONEER DIV., BENDIX-AVIATION CORP. 72, 106, 107
BENDIX RECRUITING DIVISION, BENDIX-AVIATION CORP. 160
BENDIX RADIO DIVISION, BENDIX-AVIATION CORP. 13
BENDIX SCINTILLA DIVISION, BENDIX-AVIATION CORP. 135
BOEING AIRPLANE CO., WICHITA DIV. 159
BOWER ROLLER BEARING DIV., FEDERAL MOGUL BOWER BEARINGS CO. 80
BRILES MFG. CO. 141
BUDD CO., THE 90
BULOVA WATCH CO., GOV'T. & IND. SALES 70

CALIFORNIA GENERAL, INC. 111
CANOGA DIV. UNDERWOOD CORP. 138
CARTER CO., THE J. C. 100
CHANDLER EVANS CORP. 83
CHERRY RIVET, A DIV. OF TOWNSEND CO. 63
CLIFTON PRECISION PDTS. CO., INC. ..... 3rd Cover
COHU ELECTRONICS, KIN TEL DIV. 144
COLLINS RADIO CO. 54-55
CONSOLIDATED DIESEL ELECTRIC CORP. 104-105
CONTINENTAL-DIAMOND FIBRE CORP. 96
CONVAIR DIV. GEN DYNAMICS CORP. 155
CRAIG SYSTEMS, INC. 128

DONNER SCIENTIFIC CO. 56
DORNE & MARGOLIN, INC. 117
DOUGLAS AIRCRAFT CO., INC. 51
DOW CORNING CORP., SILICONES 132

ERCO DIV., ACF INDUSTRIES, INC. 66
ESSO EXPORT CORP., AVIATION PDTS. 98

GARRETT CORP. 76
GENERAL ELECTRIC CO. 71, 78-79
GENERAL ELECTRIC CO., X-RAY DEPT. 18
B. F. GOODRICH CO. 22
HARRISON RADIATOR DIV., G.M.C. 7
HAWKER SIDDELEY AVIATION 40
HEXCEL PRODUCTS, INC. 14
HI-SHEAR RIVET TOOL CO. 9
HORKEY-MOORE ASSOCIATES 97
HYDRO-AIRE, INC. 3

INSTRUMENT DEVELOPMENT LAB., INC. 118
IRON FIREMAN MFG. CO., ELECTRONICS DIV. 145
JET PROPULSION LABORATORY 114

KINETICS CORP. 8

LEACH CORP. 84-85
LEONARD, INC., WALLACE O. 24
LISLE CORP. 119
LUKENS STEEL COMPANY 10

MACWHYTE COMPANY 42
MAGNETIC CONTROLS CO. 131
MARTIN COMPANY, THE 63
MARTIN COMPANY, MARTIN ORLANDO DIVISION 158
MELPAR, INC. 122-123
MINNEAPOLIS HONEYWELL REGULATOR COMPANY 68-69
MINNESOTA MINING & MFG. CO. 16
MISSILE DIVISION OF NORTH AMERICAN AVIATION, INC. 20
MURRAY CO., INC., A. B. 110

NASA, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION 102
NEW DEPARTURE DIV., GENERAL MOTORS CORP. 108
NEW YORK AIR BRAKE CO. 46
NICHOLS CO., W. H. 140
NON-LINEAR SYSTEMS, INC. 89

REMINGTON RAND UNIVAC DIV. SPERRY RAND 44
RESISTOFLEX CORP. 125
ROCHESTER MANUFACTURING CO. OF CALIFORNIA 151
ROHR AIRCRAFT CORP. 157
ROLLWAY BEARING COMPANY 15

SANDERS ASSOCIATES 60-61
SARGENT ENGINEERING CORP. 4
SCOTT AVIATION CORP. 146
SERVOMECHANISMS, INC. 5
SINGER MANUFACTURING CO., THE BRIDGEPORT DIV. 81
SPRAGUE ELECTRIC CO. 74
STANDARD PRESSED STEEL COMPANY 12
STILLMAN RUBBER COMPANY 77
STROMBERG-CARLSON ELECTRONICS 110
STROMBERG-CARLSON—SAN DIEGO 154
SUNDSTRAND AVIATION DIV., SUNDSTRAND AVIATION 11

TASK CORPORATION 115
TELECOMPUTING CORP. 128-129
THOMPSON FIBER GLASS CO., H. I. 130

U. S. GRAPHITE CO. 120
U. S. STEEL CORP. 142-143

VICKERS, INC., DIV. SPERRY RAND 17

WESTINGHOUSE ELEC. CORP., APPARATUS DIV. 92-93
WYANDOTTE CHEMICALS CORP. 103

YUBA CONSOLIDATED INDUSTRIES, INC. 59

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES 161-163
EQUIPMENT
(Used or Surplus New)
For Sale 164

ADVERTISERS INDEX

Boreas Corporation 164
Chemstrand Corporation 164
Chrysler Corp. 163
C. J. Colgan 164
East Coast Aviation Corp. 164
Experiment, Incorp. 162
C. S. Henry 164
International Aircraft 164
International Business Machines Corp. 161
Minneapolis-Honeywell 162
Seaboard Supply Company 164
Vitro Weapons Services 162
White & Assoc. Inc., R. E. 164
Wold Assoc., William C. 164

LETTERS

Two-Part Engine

This is in reference to the Curtiss-Wright two-part engine, in your Nov. 30 issue, p. 33.

I have conducted a one man research into this type of engine for some time and it will surprise many to know that a number of patents exist, some go back more than 30 years.

My personal research is the result of having had to design, machine and test out my own conventional motor for one of my plane designs, as none was available in the proper power range.

It seemed then, as it does now, that it was a long and tortuous way from the gas tank to the propeller, so later I laid out an ideal four-cycle function, wrapped it around a circle and optimized the least number of parts to operate it. Mechanical details await the show of firm interest by some engine manufacturer.

The workings of the Curtiss-Wright engine were explained and sketched for me by one of their engineering representatives, so I may say that the mechanism of mine is different and it oscillates less mass of metal and is simpler machined per given displacement.

This motor is in the 10-plus hp. range, is 5 in. across, and weighs 2 lb. (less ignition and carburetor). This, too, is proposed in the multi-layer version for higher power, but the optimum of course is one unit only, of the proper size. It is proposed as a throw-away power head for outboard and certain other uses, due to its utter simplicity and low cost of manufacture.

Certain business people contacted about it earlier held that there is no present market and no future for anything between the four-cycle piston engine and the true jet turbine. Of course, this is not so as the jet turbine is not readily throttlable and is a fuel gulper at low speeds. Above all, its first cost is out of all proportion for lightplane, speedboat or car applications.

Now that Curtiss-Wright's initiative and your publicity have broken the ice of complacency, it will be most interesting to watch the development of this old and suddenly new four-cycle turbine principle.

J. J. Szakacs
San Diego, Calif.

Army Conferences

This concerns the Army Aviation Conference held at Fort Monroe. This conference, as reported by Mr. Butz (AW Dec. 14, p. 34), was supposed to brief representatives of the aviation and electronics companies in the Army's requirements in aviation.

Several persons, including myself, from my company attended and were disappointed. Most of the information was contained in a set of mimeographed notes (for which one of us had to stand in line for a long time). The material given in the briefing could have been included in the notes with possibly another sheet of paper. Although the proceedings were classified confidential, the level of information was below that usually given in Aviation Week.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

The briefing was scheduled for two days, but one day would have been enough. A discussion of avionics and surveillance was indicated on the agenda, but the actual talk was of the most general and superficial nature. Of particular annoyance is the fact that the Army promised a better briefing at Fort Monmouth on Dec. 17 and 18 on avionics and surveillance.

We sent representatives to these briefings also. The results were the same; a superficial rehash of the Fort Monroe talks.

Inasmuch as the Army wants help and information from industry, we feel that the Army should be willing to give out useful information. I estimate that this go-around cost industry about one million dollars. The amount of information transferred from the Army to industry was negligible. I wonder if the Army will be surprised if industry returns the compliment.

(Name withheld by request.)
An Electronics Engineer
Rochester, N. Y.

Pilot's Reaction

This letter is directed to "Airline Passenger" in the Letters section of your Dec. 7 issue ("Pilot's Pay Cut," p. 184).

I thought the "open season" on airline pilots had quieted down. I thought we had run out of self-appointed experts, and I was sad. Now, I again feel all is well. However, do not let me misrepresent myself as being open minded and unprejudiced in the manner presented by many contributors to the Letters column. I am prejudiced.

A few reasons are:

1. I have been a pilot for 32 years.

2. I have been an airline pilot with a major carrier for 20 years.

3. During this time, I have laid my job on the line some 75 times by CAA/FAA and company physical examinations, and some 50 times by proficiency and transition flight checks.

I am, therefore, humanly sensitive to the sudden avalanche of experts who so dogmatically know what's wrong with the pilots. Certainly, pilots, like any group, are deserving of a certain amount of justified criticism. However, the theme flowing through almost all of the many letters comes to the surface, and is particularly significant, Mr. "Airline Passenger," in your letter. Your beady little green eyes are showing.

Much as I hate to, I'm afraid I must still further upset your alkaline balance. With the normal procedure on jet aircraft being to strap 150 passengers encased in 265,000 lb. of tin to our posterior extremity and send us out in the dark at 600 mph., plus the heat from Pete on this and other matters, the rates are going up, not down. In fact, you "ain't seen nothing yet."

With respect to our "behaving like pigs," it takes one to know one, and you would appear to be eminently qualified.

Welcome aboard! Invite us to your sty sometime. I'm sure it's lovely.

Oink, Oink,

J. E. Wood
Coral Gables, Fla.

Airline Safety

The hard won safety record of the scheduled airlines has fallen badly in the year 1959. One other item of significant change has accompanied this sickening drop. Gen. Quesada has taken over the reins of the FAA and the relations between the pilot group and the government agency have deteriorated to a sullen distrust.

Safety runs the range from the tangible to the completely intangible; from the testing of materials to the morale of the individual pilot in the cockpit.

I remember several years ago when the pilots of one of the major airlines were involved in an unpleasant dispute with management, and directly following this dispute there occurred three major crashes. Certainly this is not scientific cause and effect information, but human morale can be a rather unscientific area. Mr. Quesada would do well to stop spending the taxpayers' money on his "crash program" of jump seat riding and align his agency with the pilots to preserve the team spirit we need to recover and improve our excellent safety record of the past.

Mr. Quesada, your program of fear and distrust and maximum fines for infractions of confused regulations can only be followed by a "Crash Program."

Richard Oakley
Captain, Capital Airlines
Ann Arbor, Mich.

Quiet Jet Launching

To provide quiet launching of jet aircraft, a truck could be used to carry the plane to flying velocity. To power the truck, a "cold water rocket" could be used. The truck would carry a tank of water; this would be pumped to a high pressure and ejected as reaction mass. The pump power would come from a conventional gas turbine engine.

If mass of truck + plane = 10^5 kilograms, and flying speed is 60 meters/second, a water ejection velocity of 200 m/sec. would require a mass of water equal to 35,000 kg.

If acceleration to flying speed takes 15 sec., the power needed would be 40 megawatts. (Actually somewhat less power would be needed since the plane's engines provide some thrust.)

In this manner, the plane is brought up to flying speed very quietly, and then is launched with wheels up. Hence it has less drag and needn't use as much thrust. This should please the neighbors as long as they don't mind a little rain.

Jolly Brennschluss
Ed Mihrsch
Cambridge, Mass.
Harvard University

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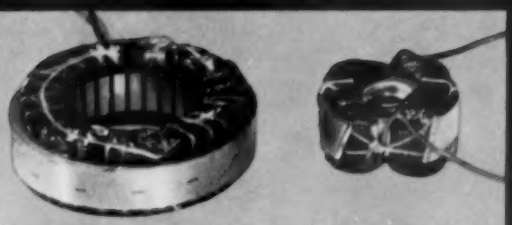
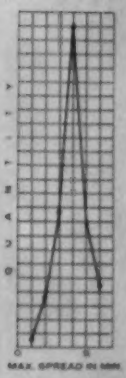
by cppc





6′ max. error spread Synchro for Gyro Pick-Off

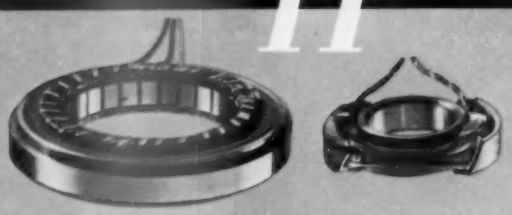
The SG-17- and ST-17- type pancake synchros (SG-18- and ST-18- with housings) are our most standard line for gyro pick-off applications.

These units have been manufactured in large quantity and are readily available for prototype breadboarding. The high accuracies shown on the left are obtainable in standard 26v or 115v units.

Pancake Resolver for Gimbal Mounting

Clifton Precision produces special pancake resolvers for direct gimbal mounting. They were developed for use in cascaded amplifier-less resolver systems and have been trimmed for 10K input impedance, 0° phase shift and a constant transformation ratio, with temperature, at 900cy. Accuracies of 4′, perpendicularities of 3′ and nulls of 1mv/v of output or less can be held.

Special techniques maintain concentricity between rotor and stator — thus reducing difficulties commonly encountered in gimbal mountings.

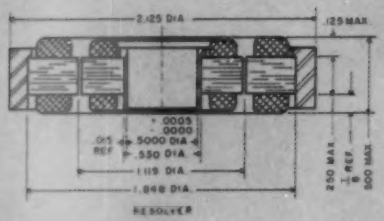


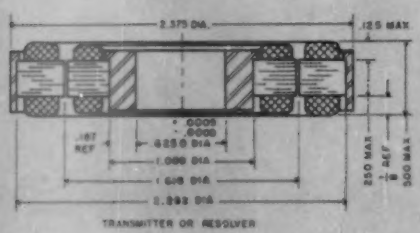
Custom Designed Pancakes

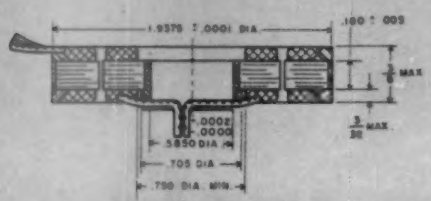
CPPC has developed a number of special pancakes (drawings below) with relatively large bores and narrow stack heights.

Means have been devised to minimize error due to clamping pressures on these thin units.

Special accuracies have been maintained where required. Let us know your needs.







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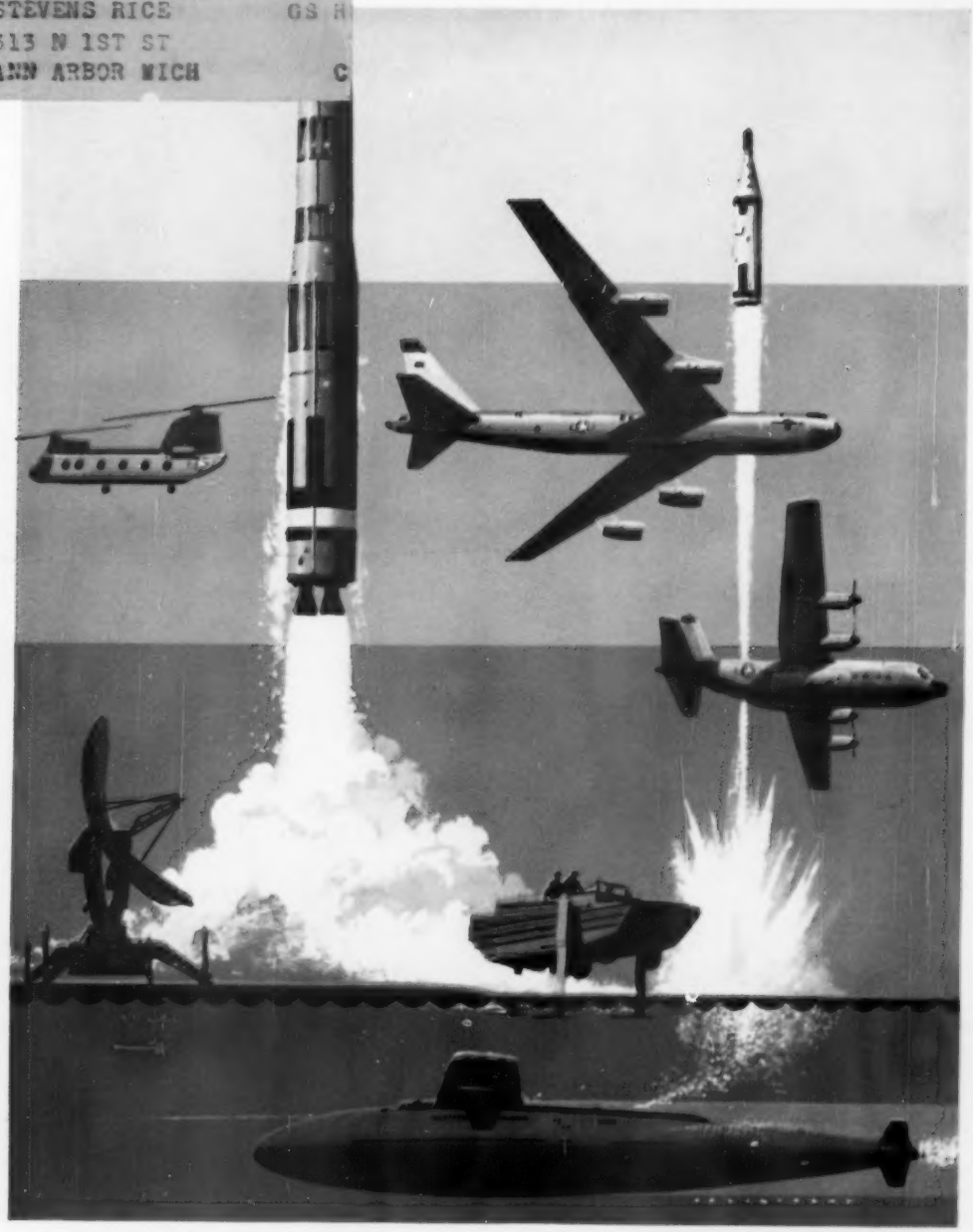

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